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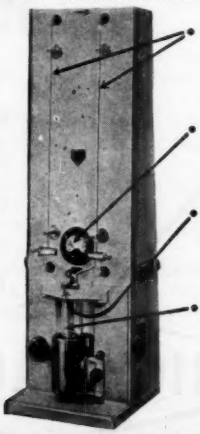

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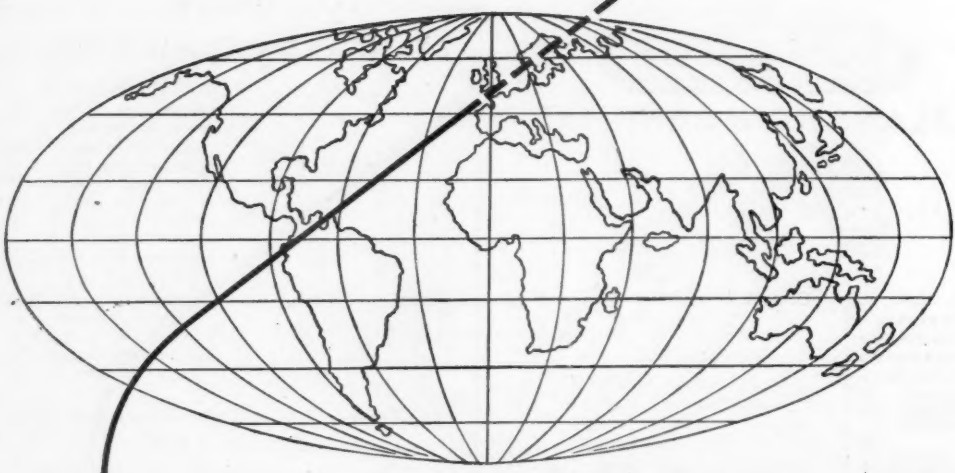

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NATURE

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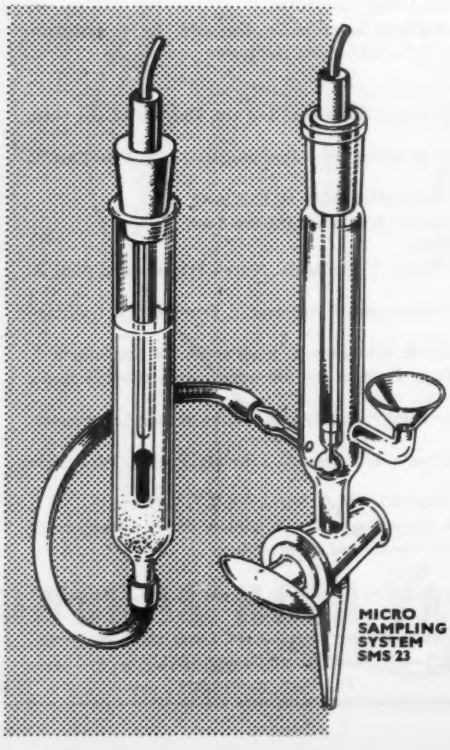

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SCHOOL, UNIVERSITY AND COMMUNITY

THE debate on the vote for the Ministry of Education in the House of Commons on April 26 well illustrates the recurrent weakness of many discussions on education in Britain during recent years. Sir David Eccles presented the estimates with his customary imaginative awareness of the real issues, and, at least for a moment when he discussed the relation of primary and secondary education to the demand for skilled man-power at all levels and the possibilities of raising educational standards, he lifted the debate out of the commonplace. He was confident that the total number of school places would soon draw ahead of the number of school children: in spite of a 30 per cent increase in the school population, the size of classes has risen, he said, by only 3 per cent. In the next five years the numbers of infants and juniors would fall by 400,000, and seniors would increase by 600,000, and last year new school places increased by that net figure.

The core of the general problem, as of some of the particular problems, is the number, and also the quality, of teachers, and here too Sir David was optimistic. Confidence, he claimed, is returning to the teaching profession. Only this, he believes, can explain the great rush for places in the training colleges, for which by April 1, 1955, there were 1,500 more applicants than in 1954, and 2,500 than at the same date in 1953. That is a factor which should assist both the maintenance of professional standards and the reduction in the size of classes, which should now be possible. Even if the substantial increase in the number of new places under construction in the current building programme fails to materialize, he said, there will still be a million new school places available in the next five years against the predicted net increase of 200,000 in the population.

Sir David did not discuss in any detail the alternatives now opened up in the way of improving standards, though he indicated that we should consider whether it is desirable to go further in reducing the size of classes; and in particular he suggested that the regulation size of secondary school classes as well as that of primary school classes might be examined. Possibilities of meeting the desire of teachers for further training, either by supplementary courses or refresher courses or by a third year of training also merit exploration, and the Minister said that he has already asked the National Advisory Council on the Training and Supply of Teachers to consider the implications of a third-year course. The county colleges and the raising of the school-leaving age may also become possibilities within the next five years, and it will require sound judgment to decide which of them is in the best interests of the children.

Sir David spoke with the report of the working party on grants to training college students in front of him, but a few days before its publication. He had referred earlier in his speech to the special allowances which he had authorized for all teachers of advanced work, and which he believes will help to secure for the profession a better share of science and mathematics graduates. This is in accordance with the report of the Appleton Committee as well as of the earlier reports from the committees of the Federation of British Industries and the National Advisory Council on the Training and Supply of Teachers in England and Wales. The Minister does not think, however, that this is a matter of money alone. He indicated that he had secured the co-operation of other government departments and of industry, and that with this help he hopes to recruit at least the minimum number of graduates required by the growing sixth forms expected in the years ahead; but he gave no indication of the supplementary measures being adopted to match either his sense of urgency or his confidence that this particular problem would be solved.

As regards the training colleges themselves, Sir David gave approval of the main recommendation of the working party as to the importance of securing uniformity in the grants made by local education authorities to students in teachers training colleges to cover expenses other than fees and boards. The report recommends that the grants should be fixed at a uniform rate for the whole country, roughly equal to the best rates now being paid, or about twice the present average, and sometimes three or four times the present grant. It also recommends that the parents' contribution should be assessed on the basis of the same income scale as is to be used for university awards. Sir David said that there would be further consultation with local authority associations before he authorized the introduction of the scheme, but meanwhile he had accepted the recommendations of the report.

Sir David also indicated that, as from next autumn, the basic allowance for board and lodging for holders of State scholarships would be increased by about ten per cent, and that State scholars who win a special prize or order of merit would be allowed to retain the cash value of the prize up to a limit of £100, without affecting the scholarship grant, provided the prize money is a single payment. The means test applied to parents' income would also be eased, both to bring somewhat higher incomes within the range of the grants and to increase substantially the allowance for parents with large families (see *Nature*, May 21, p. 881). Details of the arrangements were published on May 4, and Sir David said that he hoped the support of the local authority associations in working out these proposals would be continued.

The Minister said that he had not finished his survey of the problem of early leaving; but while he wished to see every area provide places for at least fifteen per cent of the children in grammar schools and technical schools combined, he stressed the desirability of fostering, besides the stream from grammar school to university, many strong and diverse streams leading from the secondary modern schools to the technical colleges, technological institutes and all other forms of higher education. In referring to the comprehensive school, Sir David emphasized the

value of the existing modern secondary schools and the limits which building and staffing problems place on experiments with new types of school. He suggested that it would be wiser to leave the question of the comprehensive school to the judgment of teachers themselves.

Sir David left the question of the Ashby report and adult education to the Parliamentary Secretary to the Ministry of Education in replying on the debate. In doing so, Mr. Dennis Vosper also said that there are to-day 10,900 graduate teachers of science and mathematics in our schools and that to meet our requirements this number should rise to 14,100 by 1960. At the present rate of increase, this is unlikely to be achieved; but Mr. Vosper did not indicate the steps the Minister has taken to accelerate the increase.

As regards adult education, Mr. Vosper said that, in addition to permitting higher fees and salaries for certain tutors, the Minister hopes to provide grants for a limited expansion next autumn in a few areas where there is special need. The Minister has also made it clear that he expects a further contribution towards the higher costs by an increase in fees or other means. Revision of the regulations is now being discussed with the responsible bodies. Much emphasis was laid on technical education in the debate, and Mr. Vosper stated that the provision for building technical colleges has been increased by fifty per cent during the year and that 514 courses have been approved as qualifying for the seventy-five per cent grant. Although he welcomed the co-operation with industry which finds expression in the so-called sandwich courses, Mr. Vosper did not meet Sir Hugh Linstead's query as to whether technical and technological education are not being confused and resources spread too thinly over a large number of colleges instead of concentrating on a carefully selected few.

Mr. Frederick Peert also challenged the Ministry for more imagination in regard to technical education; and although, as even this outline of the Minister's attitude indicates, there is no lack of imagination in Sir David Eccles's approach to the problem of education, it is equally clear that both he and his political opponents are in some respects too concerned to conform to party doctrines or to avoid disturbing particular interests to give full attention to the deeper issues involved. On one hand, the approach was clouded by subservience to a doctrine of equality no matter how much levelling down it involves; and on the other there is a disinclination to recognize the fact that no effective policy can hope to avoid offending some particular interests.

Those real issues are well displayed in Prof. W. R. Niblett's recent book "Education and the Modern Mind", though they were equally set forth by Dr. Eric James in the talks on a democratic education which he broadcast three years ago. Dr. James then disposed of the false idea of equality as contrasted with that of opportunity, and also of the idea that democratic education can be attained by a formula of administration or a technique or programme of instruction. Rather it is to be achieved by the creation of individual schools in which democratic ideals are to be expressed in a multiplicity of day-to-day personal relations between teachers and pupils and parents, between heads and their staffs, and between administrators and governors and schools. It will be achieved by schools which try to encourage the growth of individuality without anarchy, which stand for an ideal of equality utterly indifferent to social class or wealth, but are aware of excellence, and in which the will of the majority is sensitive to the opinions of the best. It will be achieved in communities with a sense of social obligation without a sterile conformity.

There was some recognition on both sides in the House of Commons of the importance of co-operation between administrators and governors and teachers; but save in respect of co-operation with industry in technical education, there was little awareness of the importance of the relations between the school and the community, between parents and staff. Whether we can create the type of schools which Dr. James describes depends, however, much more on the quality of the individuals who serve them than on patterns of organization or curriculum, and on the quality of the teaching staff, which in turn can be powerfully affected by the relations between school and community.

Both these factors, largely ignored in the debate, are well brought out by Prof. Niblett. Prof. Niblett emphasizes the extent to which the adolescent is affected by the society in which he is brought up, and the complexity of the views, ideals and traditions which make up any society. Whether men and women are adequate to the needs of the next half-century depends, in fact, largely on whether certain qualities rather than others are fostered within them, and which variants within the main traditions of our society are allowed the greatest scope. Prof. Niblett is discussing primarily the schools; but his words apply equally to university education and to adult education. Above all else is his argument that among the greatest needs of our time are new vision and a new depth of purpose in Western civilization, and that accordingly insight and feeling as well as thought are important, beliefs are necessary and mystery as well as knowledge have places in the mind of man.

It is from this point of view that Prof. Niblett develops his argument as to the importance of schools and universities being deeply representative of the nation they serve; but it should be noted that, in doing so, he faces frankly the issue of freedom. It is no totalitarian regime of rigid conformity which he advocates. He recognizes that there are strict limits to the range of choice and acts of will of the individual, and that it is desirable that a society should seek to influence the development of those choices and acts in certain directions rather than others. Nevertheless, he insists that in almost every situation there are choices to be made by the individual, and the real task of education is to help men and women to choose between following the traditions within them —not merely to teach them what to feel, what to think and when to act, but to help them actually to feel, to think and to act.

This is what marks off the free society from the totalitarian regime, and be it noted, it is what the

free society has continuously to preserve against the encroachments of any political party or social institution if freedom is not to decay. Here must be exercised the eternal vigilance which is the price of freedom, and nowhere more than in the process of helping the growing citizen to become more fully the possessor of the traditions which vitalize his society. On the skill, the wisdom and the vision with which the inevitable selection is done, the preservation of both the society and of freedom itself depends.

Prof. Niblett does not shirk the difficulties; but he insists that a first aim should be to enable the adolescent to choose for himself between the traditions growing within them. He insists, too, on the note of responsibility, and that the real makers and preservers of the standards, those who not only embody tradition but also extend the lines of belief, are the creative men and women of a civilization—whether poets, administrators, saints, statesmen or scientists. The test of greatness is whether men continue to find those with a reputation for being great to be the source of richness in themselves; the selection of traditions we exercise to help the adolescent must be determined by fundamental respect for the essential humanity in man. It must seek to prepare the adolescent to become responsible and to act responsibly and act alone.

A careful reading of the House of Commons debate suggests that Sir David Eccles grasps more clearly than some of his opponents why it is important, if a school is to be effective, that its influence should not run counter to trends approved by the parents of its pupils. Prof. Niblett does well to direct attention to this factor, and in his view one of the most urgent needs in English education is a much more wholehearted effort to secure closer understanding between home and school. If new experiments, such as the comprehensive school, are to succeed, and the full benefit of any inherent advantages accrue, the important point is not rigid subservience to a political theory but to secure the full understanding and co-operation of all concerned; no time spent to that end will ever be wasted.

Because so much of this education of understanding takes place out of the class-room and in the home and elsewhere, Prof. Niblett's argument bears on adult education and university and technological education as well as the schools. It is part of the functioning of a democratic society; many of the strains and maladjustments in industrial as well as social and political relations are the outcome of its neglect—of failure to learn how to judge character or to sum up a situation or to appreciate values. All in some measure need such capacities; for although they are required particularly in the leader, the leader cannot lead without people who are ready to acknowledge leadership, and especially the leadership we need most—that of men in whom material values are subordinate to others. To educate for leadership is not, Prof. Niblett remarks, a matter of educating the leader only.

Once again we see the need for a close understanding between school and university and community. Prof. Niblett puts the whole problem of education in the context of freedom, and raises the fundamental question whether, in fact, the present system of education and educational institutions in Britain fits the society in which we live. That question, and the related one whether the needs of our society demand an attempt by the various vehicles of adult education to modify group attitudes to education, and especially higher education, are the questions that have to be answered before we attempt to re-shape educational institutions to serve more effectively the varied needs of a free society. They were raised in the report on early leaving and in other reports; but Prof. Niblett challenges even more forcefully the deeper thinking that must precede any such attempt. His book indicates, too, why we must carry even further than in the recent debate on education the attempt to take education policy out of party politics. An adequate educational policy in a free society is much more than a matter of finance: it is above all a matter of public understanding and support, of the exercise of restraint, of sound judgment and of sustained interest; to carry through a policy and give those responsible for its execution the confidence which will draw to the profession men and women not only of technical competence but also of high ideals and deep human sympathies.

ENGLISH MATHEMATICIANS OF THE SIXTEENTH AND SEVENTEENTH CENTURIES

The Mathematical Practitioners of Tudor and Stuart England

By Prof. E. G. R. Taylor. Pp. xi+443+12 plates. (Cambridge: At the University Press, 1954. Published for the Institute of Navigation.) 55*s*. net.

ONE of the most neglected aspects of the history of science in England has been the development of practical mathematics before the eighteenth century. Practical mathematics had to free itself from a deep-rooted apathy, and even repugnance, in the minds of many educated men who were brought up on the classics. It had also to defend itself from the suspicions of the unlearned, who often feared that the instruments and books of mathematical practitioners were devices of the black arts.

Yet this hostility was overcome very largely through the efforts of ever-growing numbers of humble mathematical practitioners and teachers, who were centred not in the universities, but in London. By the early years of the seventeenth century, these instructors "in the Mathematikes" were well established, and their advertisements became commonplace in the increasing flow of Stuart text-books on the elementary application of mathematics, especially geometry and trigonometry, to the practical problems of navigation and surveying, and that gentlemanly hobby of dialling.

One of Prof. E. G. R. Taylor's main achievements in this well-produced book is to bring to light the important part that these men played in propagating mathematical knowledge, and in providing a broad-based foundation for the work of the more famous mathematical scientists of seventeenth-century England. Better-known figures are not left out, however, when, as the author remarks, "without loss of dignity,

a Thomas Hariot shows the sailor how to manage his cross-staff, or an Isaac Newton polishes his own speculums".

Emphasis is laid also on the significant role of the instrument-makers, who came in the main during Elizabethan times from the ranks of the engravers, and later, as science and technology advanced, from among the clock-makers, and finally were drawn from the spectacle-makers and glass-grinders. A new profession had come into being that was to produce some masterpieces in the eighteenth century.

The book is divided into three parts. The first section describes the vicissitudes and progress of the practical mathematicians from the early years of the Tudor era until 1715, when mathematics had become highly esteemed not only for its utility on land and at sea but also as a means for expressing newly discovered scientific truths about the nature of the universe itself. In the middle section, short biographies of 582 mathematical practitioners are given, and the concluding section is a chronological bibliography, with descriptive notes, of more than six hundred mathematical treatises that were published in England during this period.

Thus Prof. Taylor's latest book follows the pattern of her earlier volumes on Tudor and early Stuart geography, which also carried out accomplished forays into a little-explored and allied field. "The Mathematical Practitioners of Tudor and Stuart England" will become an invaluable reference book for historians of science, as well as an authoritative account for the general reader who wishes to know about this important aspect of the development of contemporary civilization. The Institute of Navigation must be congratulated for having sponsored this valuable book.

D. P. J. Wood

CULTIVATION OF COCOA

Cocoa

By D. H. Urquhart. (Tropical Agricultural Series.) Pp. xix+230+107 plates. (London: Longmans, Green and Co., Ltd., 1955.) 35*s*. net.

THIS book was compiled for the practical cocoa grower by a former director of agriculture in the Gold Coast. It is a composite effort, three of the chapters having been written by specialists. In his foreword, Sir Geoffrey Clay, agricultural adviser to the Secretary of State for the Colonies, stresses the fact that cocoa is a 'favoured' crop, in that there is little fear for many years to come that production will exceed consumption. This should furnish a strong incentive for the improvement of agricultural practices in countries where the crop is already established and for its extension to other areas which may be suited to it. The information given in this book should help particularly in the introduction of the crop to new areas. The more difficult problem of increasing or maintaining production in already-established cocoa-growing countries where, apart from the effect of pests and diseases, yields are rapidly diminishing is scarcely touched upon, doubtless because so little is known about the manuring of cocoa and the renovation of worn-out cocoa soils, which is a more difficult problem than the rehabilitation of existing cocoa plantations on good soil.

The book is divided into fifteen chapters. The first is introductory. The second concerns the botany of cocoa, and in it the late Prof. R. E. D. Baker, of the Imperial College of Tropical Agriculture, Trinidad, gives a clear and interesting account of the nomenclature and classification of the main types of cocoa in regard to pod and bean characters. The third chapter deals briefly with the climate under which the cocoa tree grows successfully, though it does not state the precise limits of temperature tolerance. The fourth chapter, by Prof. F. Hardy, of the Imperial College of Tropical Agriculture, deals with cocoa soils from the concept of root-room, and traces their derivation from forest soils and their various stages of deterioration under the customary methods of cocoa cultivation at present in vogue. Some means for their improvement are briefly considered, including mulching and manuring.

The next three chapters discuss practical methods of establishing and maintaining a 'seedling' cocoa plantation, and of producing rooted planting material for use in the more modern 'clonal-cuttings' plantation. The selection of suitable clonal material is not described, however, nor are the relative merits of seedlings and cuttings discussed, though the vexed questions of planting-distance and the value of overhead shade are considered at some length. The close connexion between shade and cocoa nutrition is perhaps not sufficiently stressed. The safe conclusion is reached that "all cocoa in the young seedling stage must be shaded", though, when the trees reach maturity, mutual shading may amply suffice and shade-trees may then be removed. Harvesting and the preparation of cocoa for the market, by fermentation and drying the beans, are described in Chapter 8.

The present cocoa industry of West Africa is described in the next chapter, in which its spectacular growth in the Gold Coast (which produces most of the world's crop, valued at more than £35·5 million in 1950) and its dependence on the existence of ample reserves of untouched forest land and the control of swollen-shoot virus, capsid bugs and black-pod fungus, are fully discussed. "The future of the peasant industry", it is considered, "lies chiefly with the people themselves", and their ability to take advantage of the results of scientific research. It is interesting to note that the cutting-out campaign, which was started in the Gold Coast in 1946, "has saved the main producing areas of Ashanti Province and Togoland . . ." from the complete destruction of cocoa trees by the swollen-shoot virus.

The process of rehabilitation, as evolved in Trinidad, is next described by Prof. C. Y. Shephard in Chapter 10. Rehabilitation is defined as "a simple modification of the traditional system of cocoa cultivation on good soils", in which inferior trees are systematically replaced by high-yielding clonal cuttings. It is not recommended for bad soils, and quite rightly so, because bad soils present a compact, nearly structureless surface layer devoid of crumb and humified litter, within which fibrous cocoa roots cannot adequately ramify and absorb essential nutrients. A suitable procedure is outlined; this involves thirteen operations, spread over five years, fertilizer applications being given annually in the last three years. It is too soon yet to say whether or not this procedure is likely to be completely successful, or how efficacious the use of fertilizers may prove to be.

Pests and fungal and virus diseases of cocoa are described systematically in the next two chapters. The rest of the book (three chapters) deals with grading, very briefly with cocoa research in Trinidad at the Imperial College of Tropical Agriculture and

in the Gold Coast at the West African Research Institute, and with world production and consumption of cocoa. In addition, there are eight appendixes dealing with certain technical aspects of growing cocoa, including soil surveying, farm costing, propagator design and small-scale fermentation. A notable feature of the book is the large number of excellent photographs and ten colour plates. Selected reference lists are given at the end of each chapter, and there is a good general index.

The renewed interest during recent years in the growing of cocoa and in the results of scientific research on problems connected with it has created an urgent need for a book such as this, and its author deserves the highest commendation for his successful attempt to perform a useful but difficult task.

THE ENGLISH CLIMATE

The English Climate

By Dr. C. E. P. Brooks. Pp. x+214. (London: English Universities Press, Ltd., 1954.) 12*s.* 6*d.* net.

IN this engagingly written volume Dr. C. E. P. Brooks describes the climate of Britain in relation to the major factors controlling it as well as the various weather processes and seasonal vicissitudes which make it up. Local climates are considered in much detail, largely from the human point of view in relation to such matters as bracing and relaxing conditions and the suitability of places for residence, holidays and retirement. In a discussion of 'sultry' conditions as defined by certain limits of temperature and relative humidity, there is an obscure statement on p. 114 to the effect that exposure to sunshine raises the body temperature by several degrees. This presumably refers to the external surface temperature, not the internal blood temperature, which would indicate high fever. In the chapter on "Fog and Soot" much prominence is given to the disastrous 'smog' of December 1952. The heavy death-rate from bronchitis and pneumonia is apparently attributed in the main to sulphur dioxide and soot; but it should be noted that some medical authorities maintain that, if this long-continued four-day fog had not been associated with freezing temperature in London, the mortality would have been notably less. No reference is made in this chapter to modern smoke-abatement practices and changed methods of domestic heating as bearing on the experience of the older generation that London fogs to-day have lost the sooty blackness of Victorian times.

Dr. Brooks's review of notable weather events in modern times, including storms, droughts, frosts and heat spells, leaves little unnoticed. There is no mention, however, of the prolonged intense frost in southern England during November–January 1890–91, though the famous blizzard in Devon and Cornwall which followed in March is accorded full honours. The author is right in maintaining that, while English weather is sometimes unpleasant, wild and even dangerous, these are more than compensated by many delightful moods. Essentially moderate, a stimulating variety is, he declares, to be reckoned among its greatest assets. To the more imponderable assets one would add the changeful skies and picturesque cloud scenery to which, indeed, many generations of our landscape painters have done ample justice.

L. C. W. Bonacina

SOCIAL MEDICINE

The Meaning of Social Medicine

By Iago Galdston. Pp. xii+137. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1954. Published for The Commonwealth Fund.) 22*s.* net.

DURING the past sixteen years there has been much talk of social medicine, though its advocates are not always clear as to its scope and differentiation from clinical, preventive and 'socialized' medicine. This book records the inquiries of the Secretary of the Medical Information Bureau of the New York Academy of Medicine into the subject.

In 1848 Jules Guérin seems to have coined the expression "social medicine", and defined it "as the congregate function of the separate activities differently termed medical police, public hygiene and legal medicine". Many authorities regard social medicine as the sum total of all and everything that bears on medicine and the social organism. The late Prof. René Sand gave a list of numerous components of the medical and sociological sciences which comprise social medicine. All these can be of use to the subject. But social medicine itself "must be and is something more than the sum of the sciences". It is not a new name for an old discipline.

When the chair of social medicine with its Institute was founded at Oxford in 1942, the main purposes were set out as follows: "To investigate the influence of social, genetic, environmental and domestic factors on the incidence of human disease and disability. To seek and promote measures, other than those usually employed in the practice of remedial medicine, for the protection of the individual and of the community against such forces as interfere with the full development of man's mental and physical capacity".

The subject was so attractive that the late John Ryle forsook the regius chair of physic at Cambridge to become the professor of social medicine at Oxford. Under his direction, important investigations were carried out; but when he died social medicine languished in the University. This is not surprising, for the science of social medicine is still in the making, and stern economists desire to see results which justify expenditure. Nevertheless, Oxford's example, initiated in 1939, was followed by a chair of social medicine at Birmingham and a lectureship at Sheffield, while the chair of public health at Edinburgh became the chair of public health and social medicine.

In social medicine there is a vast field of potential research, in many respects still a virgin and unexplored territory. The wide conception of the subject demands access to many branches of learning. Hence its essential growth should be in a university. Dr. I. Galdston desires similar experiments to be made in the United States. He writes: "It would be well if one or more medical schools, preferably those closely associated with universities or schools of liberal arts and in close relations with hospitals . . . would institute an experiment in the *gestalt* of social medicine. . . . It is not at all unlikely that it might have as great an effect as did that other experiment in medical education initiated by Welch and Osler some sixty years ago". To British pioneers in social medicine and to those who promoted the first chair of social medicine in Great Britain, these words are welcome and encouraging.

Arthur S. MacNalty

THE 156-in. CYCLOTRON AT LIVERPOOL

By M. J. MOORE

Nuclear Physics Research Laboratory, University of Liverpool

EARLY in 1948, it was shown that π-mesons could be produced in numbers by the bombardment of matter by α-particles produced in the Berkeley synchrocyclotron, and shortly afterwards it was proved that high-energy protons in the same machine were even more effective. The threshold for π-production by protons is about 160 MeV.; but it soon became clear that energies considerably above this value were needed for the production of significant numbers of these mesons.

After the War, Sir James Chadwick, who was then professor of physics at Liverpool, determined to initiate the building of a high-energy machine in his department. By May 1948 the above considerations had crystallized his ideas in favour of a synchrocyclotron of energy about 400 MeV., involving a magnet with poles of 13 ft. diameter. This diameter was determined by the length (32 ft. 6 in.) of the corresponding horizontal yoke plates which could be machined in one stage by the equipment available in Britain. Subsequent developments in cyclotron physics have made us wish that the size could have been somewhat larger.

Sir James Chadwick obtained funds from the Department of Scientific and Industrial Research for the synchrocyclotron, and the University received funds for the associated buildings through the University Grants Committee. The design and commissioning of the machine was the responsibility of the University, and the development contract for constructing the machine was let to the Metropolitan-Vickers Electrical Co., Ltd., in July 1948, and at the same time the building work was started by Bovis, Ltd. In the autumn of 1949, Prof. H. W. B. Skinner succeeded Sir James Chadwick, when the latter retired.

The period of building the machine was in many ways a difficult one on account of shortages of materials and trained man-power. However, the machine progressed steadily, if sometimes disappointingly slowly, until, in the middle of May 1954, an internal beam was first observed. By the beginning of July, the cyclotron was working regularly with an internal beam of the expected energy and current.

Experiments were then started on the extraction of the beam by a method described by Tuck and Teng[1] and developed by Le Couteur[2], and by the end of December a beam of high intensity had been extracted and focused into a suitable spot for experimental work. The experimental programme, concerned with the properties of fast protons, neutrons and pions, was begun on a regular basis on about January 1, 1955.

The Cyclotron Building

The main feature of the 156-in. cyclotron block is the cyclotron room with two working floors, one at about street-level and the other 8 ft. below. Adjoining the cyclotron room is a large ante-room for experimental work.

Above these are the cyclotron auxiliary equipment room, a motor hoist for raising and lowering a 30-ton screening door, a ventilation plant room and the air-blast water-cooling towers. A bridge, which carries in addition to the normal services all cables for the control of the cyclotron, joins this building to the laboratory block in which the control and particle-counting rooms are housed. As a large portion of the 156-in. synchrocyclotron room is below ground-level, it was necessary to excavate to a maximum depth of 30 ft. into sandstone. The whole of the basement was waterproofed with asphalt and the concrete oversite built to a thickness of 2 ft. From this the walls were constructed, the majority being 6-ft. thick mass concrete, although the wall dividing the cyclotron room from the ante-room is 12 ft. thick. The 46-ft. wide roof over the cyclotron is of heavily reinforced concrete 5½ ft. thick.

As a further protection from radiation, the 6-ft. external walls on two sides have an additional thickness of pulverized sandstone, which was excavated from the

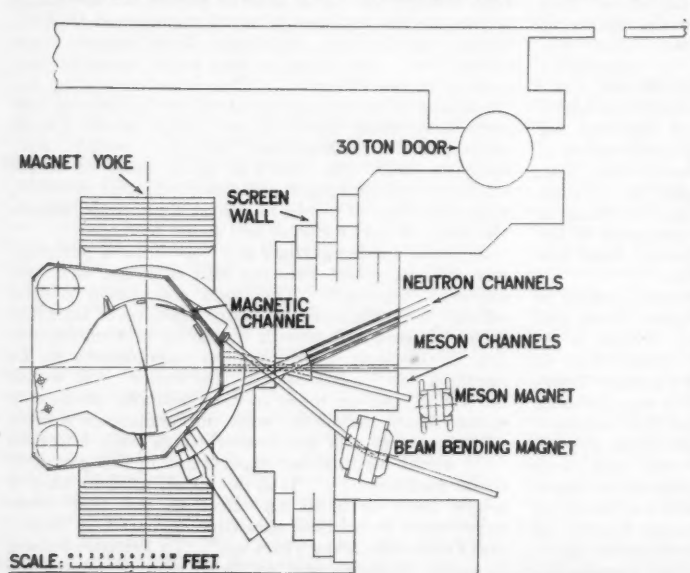

Fig. 1. Plan of cyclotron showing disposition of some of the associated apparatus

Fig. 2. The magnet in course of erection. The top coil is being moved into position prior to assembling the 13-ft. diameter top pole-pieces and top horizontal plates, which are visible in the right foreground

magnet pit, and extends 15 ft. beyond the outside face of the cyclotron wall. This packing, which rises to the height of the cyclotron room ceiling, is retained in position by a brick wall. At the maximum there is a 21-ft. wall of protective concrete, pulverized sandstone and brickwork around two sides of the cyclotron room. The third side, which faces the ante-room, has a wall of mass concrete 12 ft. thick. The fourth side has been built into the solid rock. To provide a working floor around the cyclotron at the same level as the ante-room, a floor was constructed of steel columns and beams supporting open grid steel panels. This floor is designed to take a maximum load of 70 tons (that is, the two coils) on any set of four supporting columns. It may also be readily dismantled for the removal of equipment from the lower floor-level.

For the erection of the magnet a 30-ton overhead crane was installed and supported on reinforced concrete beams which form an integral part of the concrete walls. A supplementary 2-ton crane is provided for working between the front of the cyclotron and the 12-ft. thick concrete wall separating it from the ante-room.

There are two methods of entry from the ante-room to the cyclotron room. Easy access to the cyclotron room is gained through a special doorway which takes the form of an opening through the 12-ft. concrete wall. This is closed by lifting into position a 7-ft. diameter steel cylinder filled with sand and weighing about 30 tons. For the removal of heavy plant and equipment, an opening 23 ft. wide × 9 ft. high has been left in the 12-ft. concrete wall. Prior to the commencement of experimental work the cyclotron side of this opening was sealed with steel-loaded concrete blocks manufactured to a fairly high degree of accuracy. Each of these blocks weighs 1¾ tons. The aggregate used weighs 300 lb. per foot cube (density 5) and the total thickness equivalent is 24 ft. of ordinary concrete. Channels are provided in the wall to allow beams of particles to enter the experimental room.

During the construction of the cyclotron block, 6,000 tons of sandstone and rock were excavated and 7,100 tons of concrete used. More than 5,000 tons of sandstone was eventually pulverized and used as shielding material.

The Cyclotron

The magnet of the Liverpool cyclotron has cylindrical poles, 156 in. in diameter with a maximum gap of 15·5 in. near the centre and a minimum of 11·5 in. at the edge. The yoke is built up from mild steel plates of an average thickness of 6·5 in. and a maximum weight of 23 tons. The poles are made up of disks, the maximum weight (that of the pole tips) being 30 tons each. The total weight of steel is 1,650 tons.

The energizing coils are made from 1·5-in. square aluminium conductor with a ⅝-in. diameter hole for water cooling. Each coil contains about 4·5 miles of conductor and weighs 32·5 tons. The cooling water

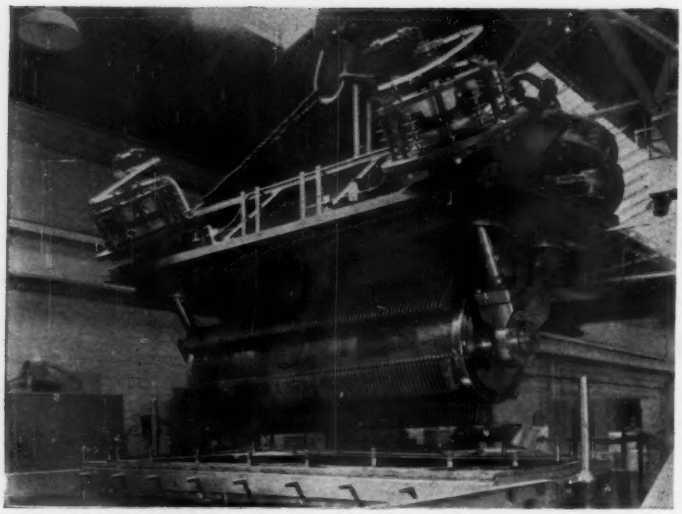

Fig. 3. The 24-in. diameter rotating condenser, which runs on 2·5-in. diameter roller bearings. The driving flange can be seen on the right-hand side. The molybdenum brushes for by-passing the radio-frequency from the bearings are between the end-plate of the condenser and the bearing housing

for the coils is demineralized and degassed in order to reduce corrosion.

With a power input of 840 kW., the centre field is 18,900 gauss, and at the maximum usable radius of 71·9 in. (where $n = -\frac{r}{H}\frac{\partial H}{\partial R} = 0{\cdot}2$) the magnetic field is 17,520 gauss. This corresponds to a proton energy of 410 MeV.

The radio-frequency system is similar to the three-quarter wave system developed by MacKenzie[3] for the Berkeley 184-in. cyclotron, where the dee is coupled through a section of transmission line to a variable capacity. The other side of the capacity is connected through a stub line to ground. It is possible to proportion the system so that it behaves like a single transmission line shorted at one end and open at the other with a capacity placed about one-third of the total distance from the shorted end. The capacity of the condenser will determine the frequency of resonance. As the capacity of the condenser increases, the minimum frequency is approached and the system behaves like a resonant quarter-wave line. As the capacity approaches zero, the maximum frequency is approached and the system behaves like a resonant three-quarter-wave line. The frequency-range required for protons is 29·2–18·9 Mc./s.

The variable capacity is built as a rotating condenser with six sets of protruding vanes which intermesh with sets of stator vanes attached to the dee-line and stub-line. It weighs about 3,000 lb. and is built up from ten sections of 'Hidurel' copper alloy. Each section is machined to form a number of 24-in. diameter disks with six blades cut in each disk. The total number of disks is eighty and the overall length of the condenser is 71 in. A variable speed electronically controlled D.C. motor drives the condenser through a rotating vacuum seal up to a speed of 2,000 r.p.m.

The dee, dee line and stub line have water-cooled copper skins built up on a light aluminium-alloy frame. The dee is suspended in the vacuum tank on four quartz insulators. The stub line stands on six porcelain insulators and is 'grounded' through a condenser.

D.C. biasing voltages are applied to the dee, stub line and rotating condenser to collect stray electrons which would otherwise oscillate in the radio-frequency field, cause discharges, and heavily load the oscillator.

The ion source follows conventional practice, with a tungsten or tantalum filament heated by a D.C. generator. The accelerating potential is supplied from a variable output D.C. generator.

The main vacuum tank is made of stainless steel and the condenser and stub line tanks of mild steel. The total volume to be evacuated is 30,000 litres and the pressure can be reduced to 3×10^{-6} mm. mercury by two 80-cm. diameter multi-stage oil diffusion pumps with a combined speed of 24,000 litres/sec. at 10^{-4} mm. mercury. The actual operating pressure, on account of the necessity for an in-leakage of hydrogen, is about 5×10^{-5} mm. mercury. Three air locks are available for use. One of these contains an adjustable probe target which can be moved in to any radius to select a proton beam of desired energy. The larger one enables apparatus up to 11 in. cube to be inserted for irradiation without impairing the vacuum, and the third is for use in the replacement of ion-source filaments. Although higher radi-

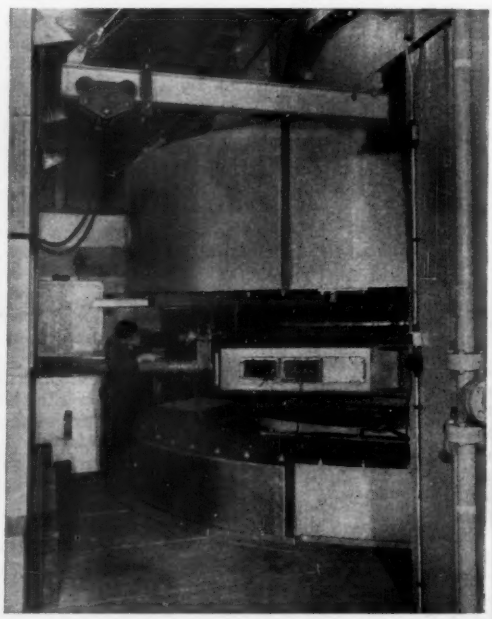

Fig. 4. The beam-exit side of the cyclotron, showing the 6-in. diameter proton tube leaving the vacuum tank and passing through the dense screen wall on the left

frequency voltages are available, the machine is at present being operated with a 'peak' dee voltage of 6·5 kV. corresponding to a power input to the oscillator of about 14 kW.

The D.C. biasing voltages for the dee, condenser and stub are 1·2, 1·0 and 3·0 kV. respectively for most satisfactory operation.

The modulation frequency used is 110 cycles per second. The mean beam current is more than 1 microampere, but no serious attempt has so far been made to increase the output of the cyclotron beyond this current.

Extraction of the Beam

The proton beam has been extracted by using the 'peeler-regenerator' system of Tuck and Teng[1] and developed by Le Couteur[2], who laid down rigid conditions for successful extraction. A note by Crewe and Le Couteur is being published in the *Review of Scientific Instruments* and a full account will shortly be published by Le Couteur, Crewe and Gregory in the *Proceedings of the Royal Society*.

The beam is extracted from the cyclotron by building up the amplitude of radial oscillations without introducing excessive vertical instability. This is realized by introducing two magnetic discontinuities at the 69-in. radius of the cyclotron and at 68° apart.

The radial oscillations, which build up exponentially with the number of transits of the beam through the magnetic extraction system, cause an increase in the separation of successive orbits. Eventually, after about fifteen turns, the orbit separation is sufficient to allow the beam to jump 1 in. into the mouth of a magnetic channel. This consists of pairs of steel bars arranged side by side. At the entrance the gap between them is 0·5 in. and their thickness is 0·25 in. The centre of the channel mouth is at the 72-in. radius. The reduced field in the channel allows the protons to pass out of the main field of the magnet.

The effects of the channel, peeler and regenerator on the median plane had to be compensated for by the introduction of additional magnetic material.

After adjustments of the components, and by centralizing the median plane by by-passing a fraction of the current through one of the magnet coils and also using the optimum total magnet current, it was found that 10 per cent of the circulating beam entered the channel. After travelling down the 6-ft. channel, the beam emerging from the cyclotron amounts to 3 per cent of the circulating beam over an area of 1½ in. square.

With a circulating beam of 1 microampere, an extracted beam of protons of 383 MeV. energy is available in the experimental room at a current of 3×10^{-2} microampere. About 70 per cent of this beam has been focused on to an area of 0·5 sq. in., at a distance of 20 ft. from the focusing magnet, giving a flux of 4×10^{10} protons/cm.²/sec. This is larger than that of any other similar machine by a factor of at least 1,000.

Neutrons having energies between 200 and 400 MeV. are available.

Provision is made for the extraction from the tank of pion beams having energies of 150 MeV. and 96 MeV.

The normal flux of the extracted 96 MeV. π^+ and 96 MeV. π^- particles is 20/cm.²/sec. and 100/cm.²/sec. respectively. A quadrupole focusing magnet is being constructed to increase these intensities.

96 MeV. π^+ particles can be produced by the external proton beam with a flux of about 5×10^3/cm.²/sec.

[1] Tuck, J. L., and Teng, L. C., Institute of Nuclear Studies, 170-in. Synchrocyclotron Report, III (Chicago, 1950).
[2] Le Couteur, K. J., *Proc. Phys. Soc.*, B, **64**, 1073 (1951); **66**, 25 (1953).
[3] MacKenzie, K. R., *Phys. Rev.*, **74**, 104 (1948).

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH*

REPORT FOR 1953–54

Research Associations

THE formation during the year of the British Steel Castings Research Association and of the Research Association for the Chalk Lime Industry brings the total of research associations in Britain to thirty-seven, while there are also four co-operative industrial research organizations which have not yet reached that status. The British Steel Castings Research Association, which is supported by 74·5 per cent of an industry with a turnover of £25 million of carbon-, low-alloy and high-alloy steel castings, is to construct a fully-equipped foundry experimental station, and its block grant of £15,000 per annum for five years from April 1, 1954, is conditional on £30,000 being received from industry, with an additional £100 for each £100 from industry up to a maximum of £10,000. Work already being carried out includes studies of the influence of moulding materials upon the incidence of hot-tearing, or local rupture of a steel casting while still at high temperature, the adherence of sand to steel castings, the development of improved and simplified forms of non-destructive testing, and of the dust-flow characteristics of the swing-frame grinding machines used in steel foundries, which have led to a device providing a simple but effective means of controlling the dust from them. Research on the causes of silicosis further supported the view that polymerization of silicic acid at critical hydrogen ion concentration is a major factor in the growth of silicotic tissue.

New terms of grant were offered to ten research associations during the year. Those for the British Flour Millers' Research Association—a block grant of £20,000 per year for five years, conditional upon receiving £30,000 from the industry, with an additional £75 for every £100 received from industry up to a maximum of £3,750—embody a return to normal conditions of grant in place of the special arrangements made during the Second World War, when the Association's activities were taken under control by the Ministry of Food. Work during the year has included further investigation of the chemical changes induced in flour by the oxidizing agents used as improvers and by atmospheric oxygen. A systematic investigation of the effects of variation in temperature of wheat passing on to the first break rolls indicated a considerable advantage in warming the wheat to 100–110° F. immediately before the first break and then cooling the resulting ground stock before further treatment. A study of inhibitors of germination and seedling growth occurring naturally indicates that

* Continued from p. 965.

extracts from oats are more active than those from wheat.

The overall effect of the Advisory Council's recommendations for the remaining nine research associations is to raise by about 40 per cent the minimum income which they are required to raise from their industries to qualify for grant and to reduce the block grant by about 20 per cent, the aggregate of the additional grants for which they can qualify being also slightly reduced. Thus, the British Cast Iron Research Association, for the five years from July 1, 1954, will receive a block grant of £40,000 per annum, conditional on receiving £100,000 from industry, and an additional £80 for each further £100 from industry up to a maximum of £16,000. Apparatus has been constructed for applying the vacuum heating method to determine hydrogen in cast iron, and work has continued on defects arising from the vitreous enamelling of iron castings and also on the effect of under-stressing on the fatigue properties of nodular cast iron. A correlation has been obtained between the percentage of cracked castings and the amount of enamelled scrap included in the cupola charges, while further work has shown that the fluidity of hypo-eutectic cast iron increases with carbon equivalent for a fixed pouring temperature.

The British Coke Research Association, which will now receive a block grant for £20,000 per annum conditional on obtaining £60,000 from industry, with a further £50 for every £100 from industry up to a maximum of £20,000, continued its fundamental studies of coke formation, the nature of coking coal and the reactivity of carbon, which have now established that the primary structure of coke and 'amorphous' carbons has two principal components: minute graphite layers, which may be present singly or in clusters of parallel but randomly orientated layers; and unorganized carbon atoms or amorphous carbon which, on X-ray examination, shows no extended regular arrangement. Investigations also continued on the influence of the chemical and physical properties of coke, on its performance in the blast furnace, and on the standardization of tests for the efficiency of coke-oven plant equipment. An improved method for determining naphthalene in coke-oven gas has been developed, and in South Wales a survey of the thermal and material balance of a blast furnace under normal operating conditions initiated a study of the wide range of problems concerned with the use of coke in blast furnaces.

For the period April 1, 1956, to March 31, 1959, the British Hat and Allied Feltmakers Research Association will receive a block grant of £9,000 per annum, conditional on receiving £12,000 from industry, with up to a further £5,000 on a cent per cent basis. Fundamental research on rabbit fur and the carrotting process and on the physical characteristics of shellac in relation to the proofing process continued, and progress has also been made in the complex and difficult problem of assessing the different types of damage to wool noils and their relation to the behaviour of the noils in processing, as well as in the study of the physical properties of felt. The fundamental studies of carrotting have led to mathematical equations relating the degree of carrotting to the composition of the liquor and to the amount of liquor applied to the fur, for both mercuric and non-mercuric-carrotting agents, which have already found industrial application. From July 1, 1957, until June 30, 1959, the Hosiery and Allied Trades Research Association will receive a block grant of £20,000 per annum, conditional on obtaining £40,000 from industry, with up to a further £8,000 on a cent per cent basis. During the year the Association's consulting service has afforded substantial savings to the industry, and among its wide range of technological investigations, excellent progress has been made in eliminating the variations in dimensions and quality of knitted fabrics and garments. Good results were obtained in factory trials of the Association's enzyme method of removing 'seeds' from cotton, and detailed studies of the bending and torsional properties of hosiery yarns and of yarn friction are in progress.

The Lace Research Association will receive a block grant of £12,000 per annum for the period January 1, 1956, to December 31, 1958, conditional on receiving £15,000 from industry, with up to a further £5,000 on a cent per cent basis. The Association's textile testing work increased, and there was a 30 per cent increase in the rate at which members submitted problems. A study of the mechanical motions of the lace machine was inaugurated, and much time was given to the investigation of the physical properties of the yarns made from new fibres. Steady progress was made in the improvement of 'Lacra' lubricant, and different grades have been developed to suit variations in the gauge and type of machines in the industry. For the period October 1, 1957, to September 30, 1959, the British Launderers' Research Association will receive a block grant of £12,000, conditional on obtaining £25,000 from industry, with up to a further £10,000 on a cent per cent basis. Studies of dirt removal and redeposition were extended to include the relation of fabric composition and construction to dirt removal and redeposition. A rapid small-scale method was devised for the extraction and estimation of grease which has proved satisfactory for use in the textile industry, and work on the effect of alkalinity on the behaviour of wash liquors has led to the development of a recommended process for wool washing. Other work has included trials of 'dipless' washing machines, the washing of rayon colours, and problems arising out of the use of fluorescent blues or 'optical brighteners' in domestic washing powders and the staining of crease-resistant or embossed finishes by albuminous material.

The Research Association of British Rubber Manufacturers, which during the year completed its removal from Croydon to Shawbury, near Shrewsbury, will receive a block grant of £17,000 per annum for the period January 1, 1954, to December 31, 1955, conditional on obtaining £30,000 from industry, with up to a further £13,000 on a cent per cent basis. The terms will be further modified for the following three years. In fundamental studies on flow characteristics, with special reference to the high rates of deformation which occur in factory processes, unexpected features have been found which may explain the behaviour of rubber during extrusion from a die. Fundamental work on the mechanism of reinforcement has brought an explanation of this baffling phenomenon in sight, while the investigations on deterioration or ageing of vulcanized rubber by atmospheric oxidation, concerned particularly with the powerful aggravating effects of metals such as copper and also with the action of 'sequestering agents' intended to render these metals harmless, are building up a picture of the complex chemical reactions involved in oxidation and its prevention. A start has been made with operational research, or more specifically, productivity surveys of the basic

operations of masticating and mixing unvulcanized rubber, which represents an annual expenditure of some £3 million in Great Britain, and, with a grant from Conditional Aid funds, the Association is preparing a series of technical manuals presenting the results of its work. The four projected will deal with compounding vulcanized natural and synthetic rubbers; electrically conductive and anti-static rubbers; ebonite; and chemical analysis and testing of rubber and raw materials used in rubber manufacture.

For the five years from April 1, 1954, the British Shipbuilding Research Association will receive a block grant of £40,000 per annum conditional upon obtaining £120,000 from industry, with an additional £100 for each £300 from industry up to a maximum of £10,000. A comprehensive series of tests, covering both propulsion and resistance, in ship-model testing-tanks on a range of models of ocean-going merchant ship forms has provided data leading to improvements in hulls, propellers and all ship/propeller combinations. Reliable data have also been secured for the first time about the resistance of a full-size ship, and considerable savings in steel as well as improvements in the construction of the ship have resulted from the work of the Association's structure-testing establishment at Glengarnock.

It has seemed appropriate to select for mention the work of the research associations the terms of grant of which have been reviewed during the year, so that an indication can be given of their contribution to the national welfare in response to these grants. Of the work of the remaining research associations, reference can only be made here to a few points of interest. Thus, the British Baking Industries Research Association has extended its work on the mechanism of crumb-softening action, the effectiveness of acetic and propionic acids as inhibitors of rope in bread, and, in collaboration with the Medical Research Council, the Ministry of Food and the British Flour Millers' Research Association, on the effect of flour and bread improvers on the health of the consumer. The British Cotton Industry Research Association has continued work in the field of productivity and on blends of various textile fibres to produce yarns and cloths with specific predetermined properties. The British Electrical and Allied Industries Research Association is still extending its network analyser, and its dispersion meter has found a new and valuable use in determining the completeness of the drying of transformers and cables during manufacture. A three-year survey of the incidence of fires in wiring installations is complete, and three full-scale models of its all-electric dryer for grass and grain are in use on farms; fundamental research on ferroelectrics has revealed the presence of both ferroelectric and anti-ferroelectric properties at different temperatures in single crystals of a niobate. The sources of germanium in Britain for semi-conductor devices was also surveyed. The British Non-Ferrous Metals Research Association reports that the investigation on melting copper alloys is now paying dividends: with the improved linings, several hundred melts of phosphorus-deoxidized copper can be carried out in place of fifty without relining the furnace. A simple treatment has been developed by which the corrosion resistance of copper alloys used in heat exchangers may be very considerably increased, and investigation of the conditions for producing lead of suitable and stable grain-size may lead to the more efficient use of lead for water pipes. The Wool Industries Research Association has developed a chromatographic method of analysis for lanthionine, and has designed an automatic controller for the woollen card as well as carried out much work on the effect of high-temperature dyeing on woollen fibres and the setting of individual fibres and their reactions to changes in relative humidity.

The immensely varied contribution to industrial advance and national welfare which the Department of Scientific and Industrial Research is making, either directly through its own research stations or indirectly through the research associations, or its support of fundamental research at the universities, is amply displayed in this report. Although it is apparent also that in terms of spending power the increased estimates provide for very little real expansion, it is no less clear that every care should be taken to see that those limited resources are spent on objectives that are unlikely to be achieved without government support. The annual report does not supply all the information required for a sound judgment on this aspect; but it goes a long way towards answering some essential questions and indicating others to which reasoned answers should be required.

ANTOINE-FRANCOIS DE FOURCROY (1755–1809)

By W. A. SMEATON
Northern Polytechnic, London, N.7

ANTOINE-FRANÇOIS DE FOURCROY, who was born in Paris on June 15, 1755, did not achieve lasting fame as an experimental chemist or the founder of a theory; but as a teacher, writer and organizer he was in the first rank, and made a valuable contribution to the progress of science during his lifetime.

His father was a pharmacist, and he was born without the advantages of wealth and influence. As a boy he was not brilliant, and after leaving the Collège d'Harcourt at the age of fourteen, with no definite plans for his career, he worked for several years as a clerk, continuing his education by reading widely in several languages. He became interested in medicine, and was fortunate in attracting the attention of Felix Vicq d'Azyr, the anatomist, who supported and encouraged him while he studied at the Écoles de Médecine. Fourcroy's student years were spent in poverty; he lodged in a garret, and lived by coaching younger students and translating foreign medical works.

While still a student, Fourcroy decided to make his career in scientific research and teaching, rather than medical practice, and he soon showed great ability. His first chemical memoir was read to the Academy of Sciences in 1777, three years before he graduated, and in 1779 he gave his first course of lectures, on chemistry and natural history, in J.-B.-M. Bucquet's laboratory at the Écoles de Médecine. Fourcroy had already established a considerable reputation when Bucquet died in 1780, aged thirty-four; but he was unable to succeed him as professor because the members of the Faculté de Médecine disapproved of his association with Vicq d'Azyr, the secretary of the Société Royale de Médecine, which was in many ways the rival of the Faculté. Fourcroy's progress was not, however, retarded. His chemical lectures continued to be popular, and in

1782 he started an annual course on materia medica in his private laboratory near Notre Dame.

P.-J. Macquer, the doyen of French chemists, died in 1784, leaving vacant the chair of chemistry at the Jardin du Roi. The chief two candidates were Fourcroy and C.-L. Berthollet (1748–1822) and, although Berthollet had the influential support of the Duc d'Orléans, Fourcroy was preferred. This was a fortunate choice, for Fourcroy was able to develop his great talent as a teacher, while Berthollet, the better experimental chemist but a poor lecturer, succeeded to Macquer's other post as technical director of the Gobelins dye-works. From 1784 until his death twenty-five years later, Fourcroy lectured at the Jardin du Roi (later called the Jardin des Plantes), and twice the lecture theatre had to be enlarged to accommodate the crowds who were eager to hear him. His knowledge of chemistry was profound, and his lectures included accounts of the latest discoveries. He was a lucid and eloquent speaker, and sometimes drew applause from his audience during a lecture.

In the laboratory, Fourcroy was as active as in the lecture theatre, and he published many memoirs on all branches of chemistry. His study of the action of ammonia on salts led to the discovery of double salts such as magnesium ammonium sulphate; but most of his inorganic research was of little significance. His chief interest was in the examination of organic substances, and in much of this work he benefited from the collaboration of N.-L. Vauquelin (1763–1829), a first-class experimental worker. They analysed many of the liquid and solid parts of plants and animals by extraction with solvents, examined the properties of the products, and in some cases tried to relate their results to those of the older method of analysis by distillation. Later they measured the relative amounts of carbon, hydrogen, oxygen and nitrogen in a number of organic substances, and although little of their work was of lasting value, it was influential at a time when organic chemistry was in its infancy.

Fourcroy was always interested in the application of science to medicine. In his course of materia medica he examined the composition and mode of action of the common medicaments, and showed that many were useless or even harmful, and some of his later memoirs dealt with the chemical effects of medicaments on the fluids and tissues of the body. He encouraged others to take a scientific interest in medicine by founding and editing a journal, *La Médecine Éclairée par les Sciences Physiques*.

Even before his election to the Academy of Sciences in 1784, Fourcroy frequently met Lavoisier, and at the end of 1786 he accepted the anti-phlogistic theory and soon became its most vigorous exponent. This was probably his most important contribution to chemistry, for his books were very widely read. In the first edition of his text-book, "Leçons Élémentaires d'Histoire Naturelle et de Chimie", published in 1782, he had favoured Macquer's modification of the phlogiston theory; but in the four editions published between 1786 and 1793, all of which were translated into English, he gave his support to Lavoisier's theory. In 1792 he summarized the new theory and its applications in a small book entitled "Philosophie Chimique", which was reprinted or revised four times and was translated into at least ten languages, and his lectures, which were attended by many foreign students, also contributed largely to the rapid spread of the theory.

Fourcroy supported the French Revolution, and in 1793 he was elected to the Convention. He intervened in few debates; but, while France was at war with most of Europe, he played a leading part in the application of science to such problems as the manufacture of gunpowder and cannons, in the organization of factories, and in the education of engineers and doctors.

In 1797 he was able to resume his scientific work, and found time to write his last and greatest book, "Système des Connaissances Chimiques", which appeared in eleven volumes in 1801; but his organizing ability could not be wasted, and Napoleon called him to the Council of State. He became director of public instruction, and was largely responsible for the foundation of the Université Impériale, which comprised the entire educational system of France from the elementary schools to the Institut. Fourcroy confidently expected to become the first 'grand master' of the Université, and he received a severe blow when Louis de Fontanes was given the office. He continued his scientific work and lectures, but the disappointment affected his health; and he died on December 11, 1809, the day that Napoleon made him a Count of the Empire.

BRITISH ASTRONOMERS AT THE TOTAL SOLAR ECLIPSE OF JUNE 20

By Prof. R. O. REDMAN, F.R.S.

THE forthcoming total eclipse of the sun of June 20 is one of rather unusual interest in that the maximum duration of totality on the centre line will exceed 7 min. and is not much below the maximum possible at any eclipse. It will be one of the longest eclipses of this century. The belt of totality starts in the Indian Ocean at sunrise, passes over Ceylon, the Andaman Islands, Thailand, French Indo-China, and the Philippines, and ends at sunset in the Pacific Ocean north of Fiji. Unfortunately, the weather prospects are poor along most of the track; the best chances of a clear sky are in eastern Ceylon, where totality will last for about five minutes. The central hills of the island will give some protection against the south-west monsoon, and mid-eclipse occurs at about 8 a.m. local time, which meteorologically is likely to be as favourable a time of day as any. Weather records from earlier years give a 60 per cent chance for clear sky; but the usual sunshine and cloudiness data are designed primarily for other purposes and give a rather imperfect assessment of the sky for intending eclipse observers, whose work can be ruined by factors not appearing in the records, for example, light cirrus clouds or excessive scintillation. Reports from astronomers already in Ceylon this year suggest that the chances of a really satisfactory sky at totality are well below the 60 per cent quoted.

Astronomers from Britain, France, Germany, Holland, Japan, Switzerland and the United States are intending to observe the eclipse. So far as is known, with the exception of two small groups who are to use aircraft in Indo-China and Fiji respectively, all are going to Ceylon and will be stationed at a number of sites in and near Polunnaruwa. In this article we shall confine ourselves to an outline of the British plans.

It is less than a year since the last total eclipse, in Sweden, where British observers were among the minority who had a sufficiently clear sky to complete most of their programmes of work successfully. This year's work from the ground will consist mainly of a repetition of some of the 1954 observations, with improvements in instruments and procedure suggested by the experience gained in Sweden. Last year, Dr. H. von Klüber (Cambridge) and Dr. A. H. Jarrett (St. Andrews) succeeded in the technically difficult feat of photographing the corona through a Fabry–Perot interferometer using the light of the green 5303 A. line. Measurement of the fringes has given a distribution over the inner corona of the line width and hence of the kinetic temperature, and this year the experiment will be repeated, using a larger solar image and photographing in the light of the red 6374 A. line, as well as in 5303 A.

Prof. C. W. Allen and Dr. E. W. Foster (London University Observatory) will again be engaged in photometry and spectroscopy of the corona with the general purpose of testing theoretical models of the electron *K* corona and the dust *F* corona. The special feature of the camera to be used for photometry is an occulting disk mounted on a tower at some distance from the lens. Its purpose is to equalize the intensity of the inner and outer corona, so that both may be satisfactorily photographed in one exposure. Their second instrument, a fast spectrograph, is also designed to record the outer and inner corona simultaneously on one photograph. An absolute photometric standardization will be provided and the polarization of the corona also will be measured.

Prof. E. Finlay-Freundlich (St. Andrews) had intended to go to Ceylon to co-operate with astronomers from the Potsdam Observatory in measuring the Einstein displacement in the star field surrounding the sun. Owing to ill-health, he has been prevented from travelling; but the Potsdam observers and equipment are in Ceylon, and will be assisted by Dr. von Klüber, who worked on this problem with Prof. Freundlich at the 1929 eclipse in Siam.

Finally, Dr. D. E. Blackwell (Cambridge), who in 1954 succeeded in photographing the outer corona from an aircraft flying at 30,000 ft. and thence in obtaining good photometric measurements out to a much greater distance from the sun than ever reached before, is this year to attempt to photograph the outer corona and zodiacal light after the eclipsed sun has set. The dust which produces the *F* component of the corona is believed to be closely associated with that giving rise to the zodiacal light, and the problem is to bridge the existing large gap in photometric measures between the two. The ordinary zodiacal light cannot be observed with the eclipsed sun above the horizon, as the sky is then much brighter than often supposed, because of light scattered in from the sides of the moon's shadow as a kind of dawn. The device of working with the eclipsed sun below the horizon has been tried a few times by other observers, but so far without success. Dr. Blackwell will work at about 10,000 ft. over the open Pacific Ocean, in a Sunderland flying boat based on Fiji. The aircraft will be provided by courtesy of the New Zealand Air Force, by arrangement with the Defence Services Research Facilities Committee of the Royal Society.

As at other recent eclipses, all British observers are working with the support of the Joint Permanent Eclipse Committee of the Royal Society and Royal Astronomical Society.

OBITUARIES

Dr. Otto Rosenheim, F.R.S.

THE announcement of the death on May 7 of Otto Rosenheim at the age of eighty-four will recall a friendly figure often seen at meetings of scientific societies in London, to many of which he was a notable contributor of highly original observations.

Rosenheim was born in Germany, where he took his Ph.D. degree at Würzburg, working under Tafel in Emil Fischer's laboratory. For part of the course he went to Bonn, and on completion of his degree to Geneva to work with Graebe. In 1895, through the mediation of Perkin, he went to Manchester for further study, and in 1901 joined Tunnicliffe in Halliburton's department at King's College, London, as research student in pharmacological chemistry; he was made lecturer in 1904, and on Tunnicliffe's departure became assistant professor of physiology. Later he became reader in biochemistry in the University of London—an appointment he relinquished in 1920.

After retiring for a few years from official duties, he went as a voluntary worker to the National Institute for Medical Research at Hampstead in 1925, and so began a second period of research which lasted for another twenty years.

In the early period, during his association with Tunnicliffe, after some preliminary work on uric acid and the quadriurates, he investigated the toxicity of beer due to the presence of selenium, and also determined the proportion of formaldehyde in milk and food which would have no effect on healthy children. In after years, he often had resort to feeding experiments in intricate problems of sterol metabolism.

With Locke he took part in the classical investigation in which a new perfusion method was devised for the mammalian heart using dextrose in oxygenated Ringer solution; but his outstanding achievement at King's College was his arduous work on the constituents of the brain. In this he was ably assisted by Mary Christine Tebb, whom he later married. They laid the bogy of protagon, around which unseemly controversy had raged. Thudichum, of whom Rosenheim was an ardent admirer, had shown in 1874 that protagon was a mixture; but Liebreich, Gamgee, Blankenhorn and Cramer believed it to be a molecular entity. Rosenheim and Miss Tebb demonstrated how dried brain treated mildly with solvents could be separated into free cholesterol, two phosphorus-free galactosides (phrenosin and kerasin) and a phosphorus-containing residue of sphingomyelin. The structures advanced by Rosenheim for phrenosin and kerasin are close to those now accepted.

In 1909 Rosenheim examined extracts of placenta, showing that if there was no putrefaction there was no pressor effect. Dixon and Tayler had claimed the contrary. Incidentally, Rosenheim identified tyramine as a product of putrefaction.

During his period of temporary retirement, Rosenheim, who was an enthusiastic rock-gardener, interested himself in some problems posed by the pigments of edelweiss and young vine leaves.

On coming to the National Institute for Medical Research in 1925, Rosenheim brought with him the problem of spermine phosphate, the conditions for the isolation of which he and his wife had already worked out. With Dudley and later with Starling's

preparative help, they elucidated the distribution and constitution of spermine and spermidine, two bases of unknown function present in mammalian tissues and fluids.

In 1925 Drummond, Rosenheim and Coward had shown that the precursor of the antirachitic substance found in foodstuffs on ultra-violet irradiation was in the fats, and in fact in the sterol fraction. With Webster, who in Leonard Hill's department had already devised a reliable technique for the testing of antirachitic substances on rats, he concentrated on the problem of the activatable sterol and arrived at the important discovery that the so-called pro-vitamin was ergosterol. This led, in the hands of Callow, Bourdillon and their collaborators, to the actual isolation of vitamin D.

In the vitamin A field, too, Rosenheim and Drummond found that the vitamin A content of cod liver oil was approximately proportional to the colour intensity produced by addition of arsenic trichloride, an observation which facilitated further advances.

In 1932 Rosenheim and I were fortunate in resolving the impasse reached in the problem of the structure of the sterols and bile acids by suggesting a revolutionary modification of the structures hitherto proposed. Great advances have flowed from the new formulæ, not only in the sterols and bile acids but also in the heart poisons, sex-hormones and constituents of the adrenals.

Rosenheim's contributions to medical science were many. He was a born investigator, meticulous and thorough in all he attempted. The uses to which he put colour reactions and mixed solvents in purification procedures were fascinating and entrancing. He was full of encouragement for the young worker. His remarkable memory and his encyclopædic knowledge were ever available and often called upon by his many colleagues. For many years he was a valued member of the Accessory Food Factors Committee of the Medical Research Council. He was a Fellow of the Linnean Society and was elected a Fellow of the Royal Society in 1927.

Harold King

Dr. R. W. Boyle

The sudden death of Robert William Boyle in London on April 18, at the age of seventy-one, has removed one of the last of that small band of pioneers who were responsible for establishing in Canada the importance of research during the early years of the present century. Born in Carbonear, Newfoundland, on October 2, 1883, the son of Dr. Albert D. Boyle and Sophie Madelock Boyle, he received his early education there and in St. John's College, from which he graduated with the award of the Newfoundland Government Jubilee Scholarship. He then entered McGill University, where he studied electrical engineering, graduating in 1905; but, stimulated by the influence of Rutherford, then Macdonald professor at McGill, he turned to a career in physics. He was awarded in 1909 the first Ph.D. granted by McGill and in the same year was chosen an 1851 Exhibition scholar, proceeding to Manchester, where he carried out research under Rutherford on the properties of radium and thorium emanations. Returning to McGill in 1911, he taught physics and mathematics, and in 1912, on the establishment of the University of Alberta, was appointed head of the Department of Physics at the new provincial institution. With his drive and enthusiasm, he established an excellent department, both for instruction and emphasis on research.

Soon after the outbreak of the First World War, Boyle joined the staff of the Board of Invention and Research, later known as the Antisubmarine Division of the Admiralty. During this period, he developed the method of submarine detection using ultrasonics produced by oscillations of quartz crystals due to their piezoelectric properties. This was a very difficult investigation at a time when electronic amplifiers were not yet available; and when the simple triode tubes eventually were obtained, he established by his drive and vision the success of what later became known as the 'Asdic'. On returning to Alberta in 1919, he continued research on ultrasonics with a small band of enthusiastic research students, making numerous fundamental measurements in this field of physics. His appointment as dean of the Faculty of Applied Science in 1921 extended his influence on research to other fields, creating in western Canada an oasis of scientific interest in original investigation that has continued ever since. The establishment of the National Research Laboratories in Ottawa required a director with energy and vision for the Division of Physics and Electrical Engineering, and Boyle was appointed to fill this new post in 1929, which position he occupied until his retirement in 1948. During this period, his Division made notable contributions to Canadian industry and, especially during the Second World War, was responsible for the major development in radar and various other devices which the Council contributed to the war effort.

Boyle was a lovable character, an interesting and vivid conversationalist, and a kindly loyal friend to all his colleagues. Travel and fishing were his particular hobbies, which occupied his period of retirement. We looked forward to his periodic return to Canada from his travels, for we were assured of a most enjoyable evening hearing of his adventures in picturesque and lively descriptions of places and people he saw and met. He will be greatly missed by his many friends in Canada and abroad.

He received many honours. Elected to the Royal Society of Canada in 1921, he was president of Section III, 1924–25, received the Flavelle Medal in 1940, and was made LL.D. by the University of Alberta in 1933. He was a Fellow of the American Physical Society, the Acoustical Society, and a member of numerous engineering societies. He is survived by two sisters, Mrs. Mary E. Watts and Mrs. Margaret B. Horton, of Billerica, Mass., and three brothers, Dr. Hubert Boyle of New Bedford, Mass., George Boyle of Grand Falls, Newfoundland, and Albert S. Boyle of Edmonton; he never married.

D. A. Keys

Mr. F. G. Simpson, C.B.E.

Frank Gerald Simpson, who died on May 14, devoted a working life of fifty years to the study of Hadrian's Wall. By training an engineer, he was fired by the possibility of scientific study which the methodically designed Roman works seemed to offer to archæological investigation. His excavations, undertaken with a precision and clarity which surpassed and surprised all professional contemporaries, reduced the apparent confusion that often attends new discoveries to problems which seemed either simple or insoluble; for they revealed that

the evolution of this most elaborate of Roman frontiers was very much more complicated than had been supposed. But in thirty years, despite the interruption of the First World War, order had been achieved: an apparently ineluctable tangle of evidence was defined, sorted and clarified, and the major problems of the relationship of Wall and Vallum, or of the many structures on the Wall itself, were solved finally and completely.

In achieving the task, Simpson not only evolved his own impeccable technique in excavation, but was among the pioneers who made of stratified pottery an exact instrument for chronology. His classification of this material, finally established in 1929, is basic for Roman studies in northern Britain and set a standard in a far wider field. His talents were early recognized by an honorary fellowship of the Society of Antiquaries of Scotland, and were presently enlisted by the University of Durham, in which he was an honorary M.A. and director of field studies during 1924–30; then, having gathered about him the nucleus of the archæological school, he made way for more regular teaching than he himself desired to undertake.

Simpson was for many years director of the Cumberland Excavation Committee and an active member of the North of England Excavation Committee; also president of the Cumberland and Westmorland Archæological Society and a vice-president of the Society of Antiquaries of Newcastle upon Tyne. The national significance of his work was fitly recognized in 1949, when he was appointed C.B.E., on the occasion of the Centenary Pilgrimage of the Roman Wall. I. A. RICHMOND

NEWS and VIEWS

Botany at Bristol: Prof. M. Skene

PROF. MACGREGOR SKENE is to retire from the Melville Wills chair of botany in the University of Bristol at the end of this session. Prof. Skene was educated at Robert Gordon's College and the University of Aberdeen, where he studied botany under J. W. H. Trail and zoology under J. Arthur Thomson. After graduating he spent more than two years in France and Germany working under L. Kny, Erwin Baur, L. Jost and C. Flahault. He returned to Aberdeen as assistant with the task of introducing plant physiology into a course until then largely systematic. During the First World War he served for four years with the Royal Field Artillery (T.F.). After a further period in Aberdeen he was appointed lecturer in the University of Bristol in 1926 and reader in 1930. In 1935 he succeeded O. V. Darbishire in the Melville Wills chair. He took part in the planning of a new wing for the biological departments, which was completed just before the outbreak of the Second World War and made possible the accommodation of the students and staff of King's College, London. Since the War he has been a member of the Developments Committee of the University and chairman of the Committee on University Grounds and Gardens. Apart from a number of original papers on physiological topics, his publications include "The Biology of Flowering Plants" and "A Flower Book for the Pocket".

Prof. E. W. Yemm

DR. EDWARD W. YEMM, reader in botany in the University, has been appointed to succeed Prof. Skene. Dr. Yemm was educated at Wyggeston School and Queen's College, Oxford. He graduated in 1931 with first-class honours in botany and was awarded the Christopher Welch biological scholarship. In 1935 he was elected to a research fellowship of Queen's College. He was for some years demonstrator in the Department of Botany of the University of Oxford, and during part of the time was in charge of the physiological research laboratory. In 1938 he was appointed to a lectureship in the University of Bristol. During the War he was at first concerned with radar work in the R.A.O.C. and later was engaged on penicillin production. After his return to Bristol he was appointed reader in 1951. For some months in 1954 he visited the United States as a Special Rockefeller Fellow. He has recently taken an active part in building up the honours school of biological chemistry. Dr. Yemm's chief research interests are physiological and ecological. His work on the nitrogen metabolism of seedlings is well known, and he has published a long series of papers on this and on related topics. He is also engaged in work on stomatal mechanisms and on the ecology of dunes.

Physics in the Durham Colleges: Prof. J. E. P. Wagstaff

PROF. J. E. P. WAGSTAFF, who retires under the age limit at the end of the present session, has held the chair of physics in the Durham Colleges since its institution in 1924. After taking a double first in the Mathematical and Natural Sciences Triposes at Cambridge, he served as a research physicist during the First World War in the Research Department of the Royal Arsenal, Woolwich. In 1920 he was appointed to a lectureship in physics in the University of Leeds, which he held until he moved to Durham. Here he faced the task of building up a new department with little assistance—only one lecturer at first—and distinctly limited resources. His success may be indicated by the increase in the number of honours students from two, in his first year, to about forty in recent years. The lecturing staff has correspondingly grown to the present number of five; successive additions to accommodation have also been made, with the result that the teaching and research facilities of the Department are now in all respects admirable. Prof. Wagstaff has always taken a great interest in teaching, and his lucid and interesting lectures, illustrated wherever possible by demonstrations, have been greatly appreciated by his students. They also owe him much for his kindly interest in them as persons, and for his constant solicitude for their welfare, maintained wherever possible after their departure from the University. Although his former students are to be found occupying all types of appointment open to the physicist, it may be said that he has always regarded the profession of teaching as of especial importance, and that he has spared no pains to provide for that profession a supply of well-trained and well-balanced graduates.

Dr. G. D. Rochester

Dr. G. D. Rochester, who is to succeed Prof. Wagstaff, is a Durham graduate, having taken his degree, with first-class honours in physics, at Armstrong College, Newcastle upon Tyne, in 1930. After spending some four years in research on band spectra with Prof. W. E. Curtis, he conducted further research in the same field at Stockholm and at Berkeley, California. He then took up an appointment as assistant lecturer in physics in the University of Manchester, where he is now reader. Although by the time he went to Manchester he had achieved a considerable reputation in spectroscopy, he abandoned this for the field of cosmic rays. In this he was no less successful, and in 1947 he discovered, with C. C. Butler, two new types of heavy, unstable, sub-nuclear particles, and thus opened up a field of study which is being energetically pursued by experimental and theoretical physicists all over the world. He has published many papers on this and other topics covering various aspects of cosmic rays. In addition to his active prosecution of research, Dr. Rochester has taken a very full share in administrative and other work at Manchester. He has acted as tutor to science students, secretary to the Ph.D. Committee, treasurer of Staff House, and has served the University in many other capacities. He has also served on a number of government and professional committees, and is at present scientific adviser in civil defence for the North-West Region of England.

Electrical Engineering in Sheffield: Prof. A. L. Cullen

Dr. A. L. Cullen, who has been appointed to the newly created chair of electrical engineering in the University of Sheffield, was born in 1920. As an undergraduate, he studied at the Imperial College of Science and Technology, London, and took his B.Sc. (Eng.) in 1940. He immediately joined the staff of the Radio Department, Royal Aircraft Establishment, Farnborough, Hants, where he was engaged on war work until 1946. During that period he made important contributions to microwave radar techniques, and carried out experiments that led to valuable new designs of waveguide aerials. In May 1946 Dr. Cullen became a lecturer in the Electrical Engineering Department at University College, London, and he is now a reader in the Department. Side by side with his teaching duties he has given much attention to research, and has published many important papers recording the results of his work. In particular, he has developed a new type of instrument for the measurement of microwave power by radiation pressure, and this is likely to become a standard of reference for this purpose at the National Physical Laboratory. He was elected a chartered electrical engineer in 1949, and obtained the Ph.D. degree in 1951. For scientific papers published in the *Proceedings of the Institution of Electrical Engineers* he was awarded the Kelvin Premium in 1952, an Extra Premium in 1953 and a Radio Section Premium in 1954. He is well known outside his own College as a lecturer, and also he is often consulted on scientific matters by government research establishments and by industrial undertakings.

Metallurgy as a Technology and Science

During recent years those in close touch with metallurgical thought and development have become increasingly conscious that metallurgy has been growing not only into a technology of ever-increasing importance but also into a science in its own right. It was therefore fitting that, in taking office as president of the Institution of Metallurgists at the annual general meeting held on May 25, Prof. F. C. Thompson should choose this as his principal theme. On the technological side he stressed the extent to which progress in other fields of science and engineering is dependent upon the ability of the metallurgist to provide alloys with special properties. To meet these needs the metallurgist has developed a wide range of new alloys—alloys with properties of strength, creep resistance, hardness, or corrosion resistance, or with magnetic characteristics which would have seemed quite impossible of attainment even thirty years ago. These advances on the technological side have been accompanied by a corresponding increase in fundamental knowledge of metals and alloys, and this has contributed in no small measure to our understanding of the solid state—in particular, of the crystalline state. As two examples of the way in which other sciences have benefited from metallurgical work, Prof. Thompson cited the light thrown on general problems of rheology by studies of the deformation and flow of metals, and the enrichment of inorganic chemistry by the work of Dr. W. Hume-Rothery and his school in elucidating many of the fundamental principles governing the interaction of atoms in alloy formation.

In his concluding remarks, Prof. Thompson referred to the continued rapid growth of the Institution and to the high standard that had come to be associated with its examinations. The Institution has rightly required that its members should have breadth of knowledge and experience; but the time may be coming when consideration should be given to the establishment of a further qualification awarded after examination to those who, having already received a broad training, have made a specialized study of a particular aspect of metallurgy. Emphasizing that these ideas were purely personal, Prof. Thompson said that such a qualification might have many beneficial effects. Associates might be encouraged to continue study until they could hope to qualify as Fellows, and in consequence the best of the colleges of technology in Britain might arrange still more advanced courses of study.

Leonard Dobbin Memorial Lecture of the Alembic Club

The Alembic Club was founded by the junior staff of the Chemistry Department of the University of Edinburgh in 1889. It is famous for its reprints of classical chemical investigations, a series of publications known as the Alembic Club Reprints, instigated mainly by Dr. Leonard Dobbin, secretary of the Club for fifty-seven years. After the death of Dr. Dobbin in 1952, the surviving members requested the Council of the Royal Society of Edinburgh to accept the entire assets of the Club and the responsibility for the continuance and extension of its series of reprints. This offer was accepted, and it was decided that the first Alembic Club Lecture under the auspices of the Society should be formally entitled the Leonard Dobbin Memorial Lecture. This Lecture was delivered by Prof. James Kendall, professor of chemistry in the University of Edinburgh, on June 6, and his subject was "Michael Faraday". Prof. Kendall remarked that Faraday's pioneer work on the liquefaction of gases is recorded in full in Alembic Club Reprint No. 12. His fundamental researches on

electricity and magnetism are well known as the basis of all practical developments in that field during the past century. In 1844, Faraday was invited to accept the chair of chemistry at the University of Edinburgh. His loyalty to the Royal Institution, however, led him to refuse; money meant nothing to him—the advancement of science was his sole objective.

British Nuclear Energy Conference

In the light of recent rapid developments in the technology of nuclear energy, and the increasing demand for a common ground between scientists and engineers where these developments can be discussed, an organization has been formed by the Institutions of Civil, Mechanical, Electrical, and Chemical Engineers, and the Institute of Physics, to satisfy this need. This will be known as the British Nuclear Energy Conference, and its affairs will be managed by a board consisting of three representatives from each of these societies. The chairman is Sir Christopher Hinton, and the secretary Mr. Alexander McDonald (secretary of the Institution of Civil Engineers, Great George Street, London, S.W.1). The five societies will arrange for the presentation of papers dealing with nuclear energy subjects, and all members of the societies will be able to attend and take part in the discussions. The Conference will publish a journal about four times a year containing records of the papers, discussions, symposia and conferences conducted by the Board. This journal will be offered for sale. The Board proposes to hold its inaugural meeting in the autumn, at which a symposium of lectures will be delivered on the technology of nuclear energy and its applications. The Board proposes to promote national and international conferences from time to time, and to arrange for British participation in international meetings. The expenses of the Conference will be met by the societies, although it is expected to be self-supporting once it is fully established.

Colonial Geology in the British Commonwealth

The quarterly bulletin of the Colonial Geological Surveys, *Colonial Geology and Mineral Resources* (London: H.M.S.O.; 7*s*. 6*d*. a number), is now well into its fifth volume. Since its inception in 1950, this publication has been an outstanding success, and in many parts of the world it must have become one of the most welcome of geological journals. Important contributions to the earlier volumes include up-to-date accounts of the geology and mineral resources of Northern Rhodesia, Sierra Leone, Nigeria, Somaliland, Jamaica, Mauritius, Trinidad and St. Helena; and of specific mineral deposits such as those of lead–zinc–vanadium at Broken Hill (Northern Rhodesia), manganese in the Gold Coast, bauxite in Jamaica, wolfram in Uganda, and coal in Bechuanaland. A regular feature of great scientific value as well as of personal interest is devoted to reports on the progress of the various Colonial Geological Surveys. No. 1 of the current volume (March 1955; pp. 126) is notable in containing a very full and well-documented report on African geochronology, which indicates that seven Pre-Cambrian orogenic cycles have now been dated in Africa, carrying geological history back at least three thousand million years. A cautiously optimistic account of the industrial possibilities of mineral wealth in Tanganyika is accompanied by geological and mineral maps of the high quality that characterizes all the illustrations of the bulletin. No. 2 (May 1955; pp. 128) contains articles on the Upper Cretaceous Mollusca of Nigeria; on the effects of heat and hydrochloric acid on cassiterite, columbite and other economic Nigerian minerals; and on the geology of a remarkable dome-like structure of concentric shells of granitic and amphibolitic rocks recently discovered on the western flank of the Sula Mountains in Sierra Leone. Besides the reports mentioned above, other regular features include notes on matters of current interest, abstracts, bibliographies, reviews and mineral statistics.

Coal Gasification in Australia

In his Masson Memorial Lecture at the meeting of the Australian and New Zealand Association for the Advancement of Science at Canberra on January 15, 1954, Dr. P. S. Andrews gave a full account of the Federal project for the pressure gasification of non-coking coals for the combined purpose of town's gas and the production of synthetic liquid fuel. Work on the gasification of brown coal in Victoria was commenced in 1931 by the technical staff of the Metropolitan Gas Co.; but the present project was based on research carried out in Germany and the United States and elsewhere. Contracts for the plant for the project were placed in 1951, and it was expected that manufacture of gas would commence in 1951 with an output of 18 million cubic feet per day, or nearly half the present requirements of Melbourne. Three hundred and seventy acres had been purchased by the Gas and Fuel Corporation of Victoria, some ninety-six miles from Melbourne, and, when completed, the initial plant would comprise six Lurgi pressure generators, two boilers fired by brown coal, with an evaporative capacity of 55,000 lb. per hr. each, and two Linde-Frankl oxygen units each capable of liquefying 500,000 cu. ft. of air per hr. for oxygen production. In addition to gas, 1 million gallons of tar and 300,000 gallons of benzole would be recovered per annum. The gas would be conveyed in an 18-in. welded steel pipe for 74 miles to the terminal station, where pressure would be reduced to 25 lb., and it would enter the present reticulation system at three points about twenty-two miles from the terminal station. Eventually the gas would be pumped to the principal country centres of Victoria, and it was expected that ultimately the gas industry would adopt the method in all the Australian States. Further research is proceeding into properties and reactivities of non-coking coals, into the interchangeability of gas from black coal and brown coal, and the dehydration, rehumidification and odorization of the gas. By 1976 an output of 60,000 million cu. ft. of 450 B.Th.U. gas was projected, with 22 million gallons of petrol and 20 million gallons of diesel and fuel oil, and recoveries from the gas of 13 million gallons of tar, 5 million gallons of high-octane benzole motor spirit and 1·5 million gallons of naphtha.

Large-scale Experiment in Weather Modification in the United States

New York University has recently reported on an extensive cloud-seeding experiment, "Project Scud", carried out along the eastern coast of the United States during 1953–54 and sponsored by the Office of Naval Research. During January–April 1953 and December 1953–April 1954, aircraft dropped 30 tons of 'dry ice' into cyclonic storms lying between Florida and Massachusetts and, in addition, 250 lb. of silver iodide was vaporized from

seventeen ground generators located between Florida and New York. The object of the trials was to determine whether cloud-seeding could change the intensity or direction of developing storms. Thirty-seven meteorological situations were selected, and seeding was carried out on eighteen occasions, the seeded and non-seeded cases being selected on a random basis and then paired. The non-seeding occasions were used as control situations. During the first period of operations, three aircraft flew along parallel tracks a hundred miles apart each dispensing 1,000 lb. of crushed 'dry ice' at the rate of 1 lb./mile; during the second period, 2,500 lb. was dispensed at 5 lb./mile along 500-mile tracks. The silver iodide generators were operated for twelve-hour periods. In trying to detect possible effects caused by the seeding, particular attention was paid to pressure changes; secondary factors were precipitation, cloud formation and wind direction. The report adds that the trials showed no evidence that statistically significant large-scale effects were caused by the seeding.

Folia Biologica: New Czechoslovak Journal

The first number of a new bi-monthly journal, *Folia Biologica*, which is the international edition of *Československá Biologie*, has recently appeared, published in Prague (from 'Artia', Smečky 30, Praha 2; 60 Kčs. a year, or 10 Kčs. an issue). The first article, on the significance of phylogenetic kinship in immunological approximation during embryogenesis, by M. Hašek and T. Hraba, is written in English and has a summary in Russian. The authors experimentally connected the extra-embryonic circulatory systems of duck and hen chicks, turkey and hen chicks, and pheasant and hen chicks, and studied the immunological results. The second article, on the growth of tumour cells in synthetic media, by M. Rychlíková and H. Keilová, is written in Russian with a summary in English and is illustrated by photographs. Two other articles are also in Russian with summaries in English: the vitality of cell fragments of yeasts—(1) plasmatic droplets of yeasts, by O. Nečas; and a method for evaluating the effect of ionizing radiation on micro-organisms (the hypotrichous ciliate protozoon *Tetrahymena gelei*), by A. Lengerová. Three articles are in Russian with summaries in German: the splitting of starch by the enzymatic complex of soils (J. Drobník); the relationship of enzymatic inversion in the soil to some microbiological tests (J. Drobník and J. Seifert); and the composition and changes in humus in some forest soils (Z. Ambrož). The number ends with a note in Russian, with a summary in English, on double-staining with acid stains in plant tissue, by I. Hršel.

Science Tools: New Swedish Journal

The firm of LKB-Produkter Fabriksaktiebolag, Stockholm, has begun issuing a new journal, *Science Tools*, which is published in English, about once every three months, and is intended to be a link between the instrument manufacturer and the laboratory research worker. The journal contains articles by well-known scientific workers dealing with modern equipment used in physical chemistry and nuclear science. In the first three numbers which have already appeared there are a number of articles of wide appeal: for example, E. Valmet and H. Svensson, on problems connected with paper electrophoresis; H. Svensson and B. Olhagen, on electrophoresis of serum and plasma in free solution without prior dialysis; and L. Hagdahl, on the use of coupled columns in chromatography. The journal is issued free to laboratory workers, who if they work in Great Britain should apply in the first place to Hudes Merchandizing Corporation, Ltd., Charter House, 52 Gloucester Place, London, W.1.

Early Carboniferous Floras

A monograph by W. J. Jongmans on "The Carboniferous Flora of Peru" (*Bull. Brit. Mus.* (*Nat. Hist.*), *Geology*, **2**, No. 5; pp. 36+10 plates; 1954; 15*s*.) emphasizes anew the wide distribution of floras of comparatively uniform aspect in the early Carboniferous in contrast with the differentiation of well-marked floral provinces in later Carboniferous times. Jongmans confirms as Lower Carboniferous the age of certain floras on the west coast of Peru which have sometimes been assigned to the later Carboniferous; he uses new collections of these compression floras to corroborate earlier results of other workers. Among the genera represented are *Rhacopteris*, *Triphyllopteris*, *Cyclostigma* and *Lepidodendropsis*; and a critical review is given of the distribution of the latter little-known genus, of which two new species are described. The general aspect of the Peruvian floras is similar to that of *Rhacopteris–Lepidodendropsis* floras of other Lower Carboniferous localities. *Lepidodendropsis* is occasionally absent, as in Australia, from the *Rhacopteris* floras, and also occurs sometimes in strata usually assigned to the Upper Devonian, as in the Donetz basin. Indeed, Jongmans suggests that the *Rhacopteris–Lepidodendropsis* floras may represent a transition between *Archaeopteris–Cyclostigma* floras of the true Devonian and later floras of the Mississippian.

The difficulty of drawing any clear-cut line between Upper Devonian and Lower Carboniferous with respect to the plants has recently been further illustrated by 'transition' floras from rich collections of petrified plants in the Devonian–Mississippian black shales of the Upper New Albany formation of Kentucky, Tennessee and Indiana. These plants comprise some twenty-nine genera, many representing stem and leaf axes, which have been reviewed and redescribed by A. T. Cross and J. H. Hoskins (*J. Paleo.*, **25**, No. 6, 713 (1951), and C.R. 3me Cong. Avanc. Études Stratigr. Carbonifère, **1**, 113 (1952) (Heerlen)). So far, no connexions between species of the compression floras and the petrified floras have been demonstrated, though the circumstances of their distribution suggest that some relationships may exist; but further evidence may well be forthcoming, for example, from the investigation of such floras as those described by Walton from the base of the Lower Carboniferous in the Kilpatrick Hills in Scotland, where the plant-remains are part petrified and part compressed. Jongmans's review focuses fresh interest on those horizons where critical stages in the evolution of the rich later Carboniferous floras, and in particular of the seed plants, may be followed up.

Rain and Plant Dispersal Mechanisms

H. J. Brodie (*Canad. J. Bot.*, 33, 2, 156; 1955) has given an account of a number of seed dispersal mechanisms of the 'springboard' type which are operated by raindrops. Most of the older accounts of seed dispersal in such genera as *Salvia* leave the impression that almost any kind of blow will set off

the discharge mechanism; it was not realized that such springboard structures are chiefly, if not exclusively, operated by raindrops. The calyx tube and pedicel of *Salvia lyrata* serve as a springboard mechanism from which the nutlets are thrown out violently when raindrops land on the distal part of the upper lip of the calyx. The force of the striking raindrop depresses the springy pedicel and, when this returns to its normal position, the nutlets are thrown from the calyx tube as a swimmer is projected from a diving board. The nutlets become surrounded by a coat of extruded mucilage as soon as they are wetted. *Ocimum basilicum* and other members of the Labiatae have similar springboard dispersal mechanisms which are operated by raindrops. The plantlets or gemmæ of the succulent plant *Kalanchoë tubiflora* develop on narrow outgrowths from the parent leaf. These attachments serve as springboards from which the plantlets are violently discharged by raindrops. The plantlets are cup-shaped and are very effective in catching raindrops. The splashing action of raindrops may sometimes be an important agency effecting the pollination of certain cup-shaped flowers such as those of *Ranunculus*. About eighteen rain-operated dispersal mechanisms are now recognized. These are distributed among four of the major groups of the plant kingdom, and it is probable that some examples will be found in all phyla of land plants.

United States National Museum: Annual Report

THE annual report for the year ended June 30, 1954, of the United States National Museum (pp. 100; Washington, D.C.: Smithsonian Institution, 1954) provides ample evidence of statesmanlike vision and executive activity at this great institution. Thus, the modernization of the hall devoted to Latin American archæology was completed and now exhibits man's cultural development from his earliest known beginnings in Latin America to the high civilizations of the Inca, Aztec and Maya. The cases show the advance of various cultures from the simple hunting, fishing and gathering level of existence to the highly advanced societies practising well-developed agriculture with complex social and political organizations and skilled technologies. The scale of the activities of this Museum may be realized from the fact that during the year nearly 650,000 individual specimens were added to the collections, which now total more than thirty-two million.

Animal Production from Grass: Meeting in Reading

THE European Association for Animal Production is holding its fifth study meeting in Reading during July 9–13. The subject of the meeting will be "Animal Production from Grass"; Prof. M. M. Cooper, of King's College (University of Durham), Newcastle upon Tyne, will give a paper on animal management for intensive production from grass, and there will also be a paper by two Dutch contributors. About 100–150 delegates are expected. Before the meeting there will be a visit to the Royal Show at Nottingham and to the Research Farm at Thurgarton, Nottingham, of Boots Pure Drug Co., Ltd. Visits will also be made to the Grassland Research Station, Hurley, the National Institute for Research in Dairying, Shinfield, and to Mr. Maurice Passmore's farm in Warwickshire. The arrangements for the meeting are being made by the British Society of Animal Production, which is the United Kingdom member of the European Association. Further information can be obtained from the secretary-treasurer of the Society, J. P. Maule, Commonwealth Bureau of Animal Breeding and Genetics, King's Buildings, West Mains Road, Edinburgh 9.

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: A. P. A. Forbes (chief agricultural officer, Nyasaland), deputy director of agriculture, Tanganyika; C. R. Groves (assistant director of agriculture, Bermuda), director of agriculture, Bermuda; J. R. P. Soper (deputy director of agriculture, Tanganyika), director of agriculture, Tanganyika; E. Williams (assistant director of agriculture, Nyasaland), deputy director of agriculture, Nyasaland; K. E. Woodcock (field officer, Insecticide Research Department, Tanganyika), field officer, Tsetse Control Department, Uganda; J. O. Meehan, assistant conservator of forests, Northern Rhodesia; R. Pickering, geologist, Tanganyika; J. R. Cutler, scientific officer, West African Stored Products Research Institute, Nigeria; M. J. Henigan, veterinary officer, Singapore; C. H. Brown, senior principal scientific officer, British Guiana and British Honduras.

Announcements

PROF. SERGEI BERNSTEIN, formerly director of the Institute of Mathematical Sciences, Kharkov, and Prof. Bernard Houssay, director of the Institute of Experimental Biology and Medicine, Buenos Aires, have been elected foreign associates of the Paris Academy of Sciences.

THE following appointments have been made in the Imperial College of Science and Technology, London: Dr. J. H. Argyris, reader in the theory of aeronautical structures, to the University chair of aeronautical structures; and Dr. G. D. Hobson, lecturer in oil technology, to the University readership in oil technology.

THE new Water Pollution Research Laboratory at Stevenage of the Department of Scientific and Industrial Research will be opened by the Lord President of the Council on June 20 at 3.30 p.m.

THE Royal Meteorological Society will hold a two-day meeting during July 21–23 in Ashburne Hall, University of Manchester, which will be open, without entrance fee, to non-members. The meeting will take the form of two symposia on "Some Aspects of Turbulence in the Atmosphere" and on oceanographic topics, respectively. Bookings for accommodation, excursion, etc., should be made not later than July 7; further information and reservation forms are available from the Assistant Secretary of the Society, 49 Cromwell Road, London, S.W.7.

THE British Association's Division for Social and International Relations of Science will be holding a conference on "Land Use" during July 15–16 in the Washington Singer Hall, University College of the South-West, Exeter, under the chairmanship of Mr. P. Ritchie Calder. The topics to be discussed will be: the allocation of land—the administrative functions of central and local government; the need of land—agriculture and forestry; the preservation of amenities in relation to land use; the needs of the Armed Forces for land; the need of land for mineral exploitation—land restoration; and the need of land for urban and industrial development. Further information can be obtained from the Secretary, British Association, Burlington House, London, W.1.

NEW LABORATORIES FOR INORGANIC AND PHYSICAL CHEMISTRY IN THE UNIVERSITY OF LIVERPOOL

THE new Laboratories of Inorganic and Physical Chemistry in the University of Liverpool were opened by H.R.H. the Duke of Edinburgh on May 11. The building is one of the first to be completed according to the plan and in the area set aside for the development of the University. The laboratories, of a total floor area of 88,000 sq. ft., provide for the teaching of both inorganic and physical chemistry at the various levels of training required for students specializing in chemistry and for those students who study chemistry as a preparation for specialization in medicine, dentistry, veterinary science, engineering and metallurgy. The laboratories provide places for some four hundred undergraduates at any one time, and for forty to fifty research workers.

The building (Fig. 1) comprises two large wings, each of two stories, with a connecting spine of three stories from pavement-level. The latter contains specialized laboratories and research, staff and cloak rooms. In each of the wings are located two large laboratories one above the other for undergraduate teaching. Each laboratory is serviced by a sub-store connected to the main store by a goods lift, and has a balance room and fume room attached. In addition, there are rooms for special teaching purposes. The basement, which extends throughout the wings and the spine, houses the main stores, workshops, glass-blowing, electronic and photographic rooms, and the air-conditioning, heating, liquid nitrogen and electrical plant. The main stores and the separate underground acid and solvents stores are served from ground-level by a goods lift situated in the small extension adjoining the side entrance to the laboratory.

The design of the building is essentially functional. It is built with a steel frame, the walls being of cavity brickwork with specially selected facing brick. The structural floors are of reinforced concrete, and air-conditioning ducts are carried in the space between floor and ceiling.

Floors in all laboratories and staff rooms are finished with narrow strip African mahogany (karuin) boards. The corridor on the ground floor, stair treads, and stair landings and halls are floored with terrazzo tiles. Walls and ceiling are plastered and protected by acid-proof paint.

The heating of the building is by low-pressure hot water, within invisible ceiling panels. The boilers are oil-fired, the heating system being operated in conjunction with the air-conditioning plant, and all rooms are thermostatically controlled.

In addition to the normal a.c. electricity supply, d.c. is available from fixed and mobile rectifier units. Lighting is by tungsten lamps, except in the basement rooms and corridors, where fluorescent strip is used.

The building was constructed on the general principle that all service pipes were to be accessible, and that fixed horizontal drains either in or under the floors were to be avoided. The main pipes and conduits carrying the services, which include gas, hot and cold water, compressed air, distilled water and electricity, and also the heating mains, are slung at ceiling-level along the full length of the basement trolley-way. Branch mains from the main service pipes are run vertically in the service ducts, and the smaller horizontal branches which service individual benches are concealed behind removable polished plywood panels.

The avoidance of floor drains meant a change from the traditional type of 'island' laboratory bench to the 'peninsular' type. All horizontal wastes are within the bench casing above floor-level and discharge

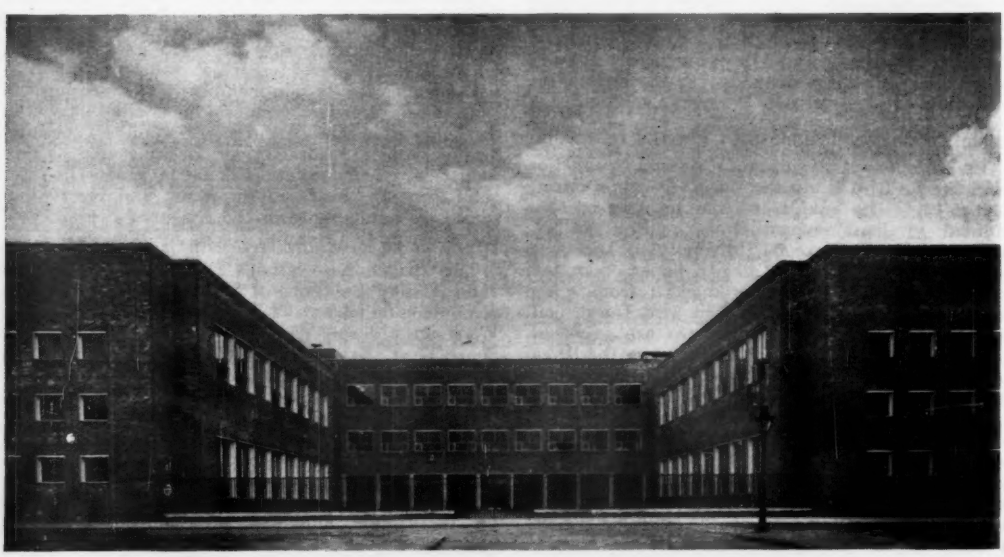

Fig. 1. Front view of Inorganic and Physical Chemistry Laboratories, University of Liverpool

directly into the catchpot, which in turn discharges into a vertical drain stack. The vertical acid-drain stacks occur at 10-ft. intervals, that is, at every steel stanchion between windows and on the centre lines of laboratory benches.

Service pipes to these benches branch off the lines under the window benches, the water, compressed-air pipes and electricity conduits running under the reagent shelf spaced at 15 in. above bench-level, while the gas tubing is taken alongside the waste trough under the bench top. Only gas controls are on the bench top, and these are raised above bench-level to reduce corrosion and to ease cleaning and polishing of the benches. Removal waste bins are an integral part of the bench design.

Polythene ('Vulcathene') has been used for lining the central waste troughs in the benches and the waste pipes from benches, drip sockets and sink traps in all laboratories. The latter, being precision made and thus identical, are readily interchangeable and saved much time and labour in the construction and erection of the benches. The bench tops are constructed of seasoned African teak, and alternate laboratory benches are fitted with a glazed sink or a readily removable inset so that a standard thermostat projecting 9 in. above the bench-level can be inserted. Water, gas and general fittings to the bench are of gun metal.

In all teaching and research laboratories, foul air is extracted at both floor- and ceiling-levels.

Fume cupboards in the teaching laboratories are in a special fume room at one end of the laboratory. The controls for the service points are external and mounted on a black plastic panel under the cupboard working surface. Each fume cupboard is lighted by fluorescent tube fixed above the working surface, and protected from fumes by a removable sheet of obscured glass. Fumes are extracted from the cupboards through high- and low-level outlets in the rear walls by exhaust motors situated in the roof of the building and individually controlled.

The research laboratories have not been individually designed for specialized work, the services and layout being sufficiently flexible for the laboratory to be adapted to any type of chemical research work. Only a few of the laboratories have fixed benches, and in general the normal services have been made available from a 9-in. shelf attached to the wall at 3 ft. above the floor. This arrangement permits full use of space. Soft-wood tables (or metal frames where necessary) of various heights and designs are used for the erection of apparatus. Additional equipment in research rooms are wall channelling, and floor- and ceiling-tapped sockets which may be used for the attachment of blackboard, shelves, electrical apparatus and small-diameter 'scaffolding' for supporting a metal framework. The wall channelling is of a C cross-section, so that threaded bolts can be slid along to any position horizontally, the head of the bolt being in the channel and the threaded shank projecting outwards. The floor sockets are directly below those in the ceiling, and all are at 3-ft. centres, in both directions.

It is proposed to complete the present building within the next two years by the addition of a lecture theatre block comprising three lecture theatres seating 300, 150 and 100, respectively. This block will also house the library and small seminar rooms, and will form a third wing to the main spine. The spine will also be extended to accommodate the newly created Sub-department of Radiochemistry.

HARWELL MEETING OF THE PHYSICAL SOCIETY

THE spring meeting of the Physical Society was held at the Atomic Energy Research Establishment, Harwell, during March 31–April 2; the first day was taken up by discussion of topics connected with nuclear energy-levels, the second with topics connected with neutron physics, and there was a visit to the Harwell laboratories on the morning of April 2. About two hundred and fifty people attended, including several visitors from the Continent of Europe; most of the talks were given by physicists from Harwell and Oxford, the other contributions being from Cambridge and the Imperial College of Science and Technology, London.

The subject of nuclear energy-levels was introduced by B. H. Flowers (Harwell) with a review of the theory of the low-lying levels of nuclei. He directed attention to the contrast between the independent particle (the 'quasi-atomic') model of the nucleus, the chief success of which lies in light nuclei; and the collective, or 'quasi-molecular' model, which has accounted for many of the properties of heavy nuclei. In the first model, one takes a central core with one or more external particles, and considers the interactions between the particles and between the particles and the core. The interaction is usually taken, at one extreme, as pure spin-orbit (*j–j* coupling) or, at the other extreme, as a force derived from a central two-body potential (*L–S* coupling). Alternatively, a mixture of the two interactions (intermediate coupling) has been used with success, as Lane has shown with reference to the lithium isotopes and the mirror nuclei carbon-13 and nitrogen-13. Dr. Flowers suggested that experimental evidence should be sought for the odd-parity levels of nuclei between oxygen and calcium; near oxygen these levels probably correspond to 1*p* particles being raised to the 2*s* or 1*d* shells, and near calcium to 1*d* or 2*s* particles being raised to the 2*p* or 1*f* shells. He said that the sequence of spins of these odd-parity levels in oxygen-17 has been observed, by comparison with fluorine-17, to be 1/2, 7/2 and 3/2, as expected; and that he would expect the corresponding sequence of spins for calcium to be 7/2, 3/2 and 1/2. For aluminium-25, intermediate between oxygen and calcium, he would expect an intermediate order, as has been found to be the case. Further theoretical evidence for the validity of intermediate coupling in nuclei with atomic masses between 18 and 20 was later presented by J. P. Elliott (Harwell); many of the experimental data can be fitted with a single value of the coupling parameter, and, in particular for fluorine-19, the energies of the lower even-parity levels, the probability of transitions between these levels, and the log *ft* values for oxygen-19 and neon-19 decay, can all be accounted for. Experimental evidence for the transition probabilities from the first four levels in fluorine-19, as determined by the gamma-rays from fast-neutron inelastic scattering, was presented by J. M. Freeman (Harwell): the levels were established both by the gamma-ray energies and from excitation functions. In addition to well-established levels, there was good evidence for a level at 1·43 MeV., probably of negative parity. G. Dearnaley (Cambridge) showed results of interesting interference effects which occur when protons or alpha-particles are scattered by fluorine nuclei: the

interference, at a resonance where there is no spin change, occurs because of the interference between the compound nucleus and Rutherford scattering.

Proceeding to the collective or 'quasi-molecular' model of the nucleus, Dr. Flowers referred to the success of the Bohr–Mottelson picture of the rotational levels of even–even nuclei. The moment of inertia of the 'rotating' nucleus is $I = \gamma\beta^2 I_0$, where I_0 is the moment of inertia of a rigid sphere, and β^2 is a distortion parameter. In the Bohr–Mottelson theory, which assumes no vortex motion, the coefficient γ equals 1: but since optical spectrometry (isotope shift) gives β^2, and nuclear levels give $\gamma\beta^2$, the coefficient γ has been found experimentally to be 4 ± 1, in accordance with the theory of Blin-Stoyle and Weisskopf, which includes the orbital motions of the shell model. A study in the United States by Mrs. Scharff-Goldhaber has shown that if one plots E_2/E_1, the ratio of the experimentally determined energies of the second and first excited states of even–even nuclei, as a function of atomic weight, one finds, for heavy nuclei, the value of 3·3, as predicted from the Bohr–Mottelson theory. Near atomic mass 150, however, there is a sharp drop to a reasonably constant value 2·1, even though the individual values of E_1 vary between 0·2 and 2 MeV. Clearly, there is a collective feature present in the nuclei of intermediate weight. In the ensuing discussion, it appeared that the ratio of 2·5 for E_2/E_1 had been derived at Copenhagen by introducing two distortion parameters and large deviations from spherical symmetry. Experimental evidence on collective particle phenomena was given by J. O. Newton (Harwell) in a study of Coulomb excitation of odd Z–even A heavy nuclei. In these, unless the projection of the angular momentum on the axis of deformation is $\frac{1}{2}$, the ratio E_2/E_1 should be a constant determined by the ground-state J: the experimental results give satisfactory agreement for neptunium-237 and uranium-233 (both spin 5/2) and for plutonium-239 (spin 1/2, and therefore no relation for E_2/E_1). For uranium-235, the data could fit spin 5/2 or 7/2, and bear no relation to the levels observed in the alpha decay of plutonium-239; this confirms that, in the latter, the levels excited are not the rotational levels based on a ground-state of uranium-235.

Part of one session was given to work from the Harwell cyclotron. Protons scattered out of the cyclotron at 20° from carbon are 70 per cent polarized, and M. J. Brinkworth and B. Rose showed that by slowing down the protons in aluminium to the energy range 2–10 MeV. and scattering a second time in helium, the sign of the polarization can be determined from the known scattering of protons in helium. The sign of the polarization so determined agrees with the sign predicted by Fermi on the basis of the shell-model spin–orbit interaction. Total cross-sections and angular distributions for 140-MeV. protons scattered by beryllium, carbon, nitrogen and oxygen were discussed by A. E. Taylor and E. Wood. The angular distributions showed large Coulomb-nuclear interference and were in agreement with the modified optical model predictions; the total nuclear cross-sections showed close agreement with neutron total cross-sections, except for beryllium which is an odd-neutron nucleus. Measurements of total cross-sections with light and heavy water and with liquid hydrogen showed close agreement between n–n (from the n–D and n–p difference) and p–p scattering, and between the two values of n–p, direct and from the p–D and p–p difference. R. Wilson (Oxford) reported measurements of neutron inelastic cross-sections for carbon, aluminium, copper, cadmium and lead in the energy range 55–140 MeV. The results showed little variation with energy, in contrast to the total cross-sections. Measurements of the elastic scattering for the same elements and for lithium, beryllium, and nitrogen and oxygen molecules at 135 MeV. indicated that the 0° scattering cross-sections were larger than those expected on the optical model, and that the potential in the optical model does not fall to zero at this energy.

The main subject dealt with in the field of slow-neutron physics was the interaction of thermal neutrons with solids and liquids, the subject being introduced by R. J. Elliott (Harwell). Thermal neutrons have wave-lengths in the range 1–10 A. and are therefore useful for studying the structure of solids; and since the cross-sections of most nuclei are of the same order of magnitude, the positions of atoms such as hydrogen, which are difficult to find by X-rays, can be obtained with neutrons. There is also an interaction between the neutron's magnetic moment and the magnetic moment of an atom, so that magnetic order can be studied with neutrons as well.

The location of hydrogen atoms in organic compounds was later discussed in a paper by G. E. Bacon (Harwell). He said that once the problem of extinction had been properly understood, it was realized that large single crystals could be used for neutron diffraction studies, and this development has made the study of the position of hydrogen atoms in organic compounds feasible. At present, work is going on at Harwell and in the United States at Oak Ridge on several organic compounds. Because of the relatively weak neutron beams available from reactors at the present time, the substances under study are those for which some X-ray data are available: the technique is then to obtain, by Fourier analysis, a projection of the crystal on a single plane only. Bacon showed the results he has obtained on α-resorcinol, in which the positions of the hydrogen atoms have been accurately established for the first time: in this work he used a crystal 1 cm. × 2 mm. × 3 mm.

Continuing his review, Dr. Elliott explained that, in addition to the elastic scattering which is being studied in these experiments, the inelastic processes in which the neutron exchanges energy with the solid are of great interest. Since the energy of thermal neutrons is of the same order as the separation of the energy-levels of solids, the excitation or de-excitation of the levels can be studied comparatively easily. Again, because of the nuclear and magnetic interactions, the information obtained is related to both the vibrational and magnetic energy-states of the solid. Unfortunately, because of the relatively weak neutron beams available, really detailed experiments are not yet feasible. However, R. D. Lowde (Harwell) described the data he has obtained from a study of the inelastic scattering of a beam of thermal neutrons by a single crystal of iron. Here both the vibrational and magnetic type of inelastic scattering are important; but by suitable techniques the observational data may be separated into the two components. The magnetic scattering has been compared to that predicted by the Heisenberg and the collective-electron theories of ferromagnetism. At present, the data are accounted for satisfactorily by the Heisenberg model only. Further studies in the neighbourhood of the Curie point have confirmed

that the magnetic scattering reaches a maximum there, and that that phenomenon is analogous to 'critical opalescence'.

The scattering of neutrons by crystalline solids can be described in a relatively exact fashion because the positions of the atoms are relatively well defined. However, Dr. Elliott continued, when more complex substances such as liquids are considered, the scattering is described in terms of a pair distribution function (that is, the distribution of atoms in the liquid as seen from an atom at the origin). For X-ray scattering, only the dependence of the pair distribution function upon the distance between atoms is measured, but for neutron scattering the dependence upon time as well is important. The detailed behaviour of the pair distribution function with respect to time and distance can be found by measuring the differential scattering cross-section per unit solid angle and unit interval of the energy of the scattered neutron.

Again, detailed study of this kind is not yet feasible; but a preliminary experiment on the scattering of 14° K. neutrons by solid and liquid lead was described by P. A. Egelstaff (Harwell). The object of the work was to compare the interaction of the neutrons with the thermal vibrations of the solid and liquid. It was shown that the chief features of the experimental data can be explained by assuming that the liquid is "a solid with the atoms placed at random positions". However, some features of the forward scattering require a more detailed model for their explanation.

Limitation of space does not permit a detailed review of all the contributions to the meeting, but mention should be made of the subject of very short half-lives. Prof. S. Devons described the work at the Imperial College of Science and Technology, London, on measurements of absolute gamma transition probabilities by the Doppler shift of the gamma-rays emitted by a recoiling compound nucleus. Here, unexpectedly, the chief unknown has proved to be the rate of slowing down of the heavy particles in the material into which they recoiled. Information is being sought from the recoil of $^7Be^*$ into varying thicknesses of copper: it was noted that the experimental values of the absolute transition probabilities for $^7Be^*$ and $^7Li^*$ lie respectively above and below the values predicted by intermediate coupling theory. C. F. Coleman (Harwell) described a method of determining half-lives down to 10^{-11} sec. by means of fast coincidence techniques. The method depends on $\beta\gamma$ coincidences between two identical detectors placed at 180° with respect to the sample, and differing only in the absorber screening the gamma detector. Alternating the absorber between the detectors enables small delays between the detectors to be cancelled out. The life-times observed (in units of 10^{-12} sec.) are: magnesium-24, 30 ± 2; titanium-46, 7 ± 4; nickel-60, 8 ± 5; selenium-76, 25 ± 10; tellurium-122, 196 ± 5; and tellurium-124, 13 ± 12.

M. A. Grace (Oxford) described experiments on the alignment of cobalt-57 at very low temperatures. The determination of polarization correlation with aligned nuclei enabled him to determine the degree of E_2 and M_1 admixtures in the 123-keV. gamma-ray. R. Batchelor (Harwell) described a helium-3 spectrometer for use in the 100–1,000 keV. neutron range. The cross-section of helium-3 in the $^3He(n,p)T$ reaction has given results in good agreement with those derived from detailed balancing, and the instrument has been used for determining the intensity and angular distribution near threshold of the $^7Li(p,n)^7Be^*$ reaction. Of the $Cu(n,p)$ reaction at 14 MeV. neutron energy, D. L. Allan (Harwell) showed that the number of protons below the conventional Coulomb barrier at 7 MeV. is far in excess (85 per cent of the total) of those expected, and bears a general resemblance to the distribution observed by Graves and Rosen of the neutrons from the parallel $Cu(n,n)$ reaction. Finally, the redetermination of the slow-neutron capture cross-section of hydrogen was reported by C. H. Collie and R. E. Meads (Oxford). Neutrons from a pulsed D–D source were slowed down in a tank, and the gamma-rays from their capture were detected in a scintillation counter. The life-time, obtained from the decay-rate of the gamma-ray yield integrated over the tank, was 203 ± 2 μsec., corresponding to a capture cross-section of 0·335 barn for a neutron velocity of 2,200 m./sec.

Other contributors were L. E. Beghian (Oxford) on gamma-rays from fast-neutron scattering; D. B. Gayther and K. P. Nicholson (Harwell) on neutron total cross-sections at intermediate energies; M. J. Poole (Harwell) on the spectrum of neutrons from a water moderator by time-of-flight analysis; P. C. Price (Cambridge) on the radiative capture of alpha-particles in nitrogen; E. R. Rae and J. E. Lynn (Harwell) on the analysis of levels in uranium-238 with a time-of-flight spectrometer; T. H. R. Skyrme (Harwell) on the alpha-particle and shell models of the nucleus; and J. F. Turner (Harwell) on the low-intensity radiations in the decay of cobalt-60.

W. D. Allen
P. A. Egelstaff

MATERIALS FOR RADIO VALVES

At a meeting of the Radio Section of the Institution of Electrical Engineers on March 21, a discussion was opened by Dr. R. O. Jenkins on the subject of "Materials for Valves". He stated that, historically, the technique of valve-making was derived from that of lamp-making, so that valves tended to use materials originally developed for lamps. With recent advances, however, modern valves require different and, in some cases, new materials; and since the quantities required are relatively small, it has not always been easy to persuade the supplier of materials to meet the very stringent specification of the valve manufacturer.

In addition to the opening speaker, nine others participated in the discussion. It was generally agreed that most of the materials used in valve manufacture are capable of great improvement, and it was suggested that the preparation of idealized specifications would encourage the supply of satisfactory materials in adequate quantities. The subject was surveyed under the three main headings of cathodes and heaters; other electrodes; and envelopes of both insulators and metals.

It was recognized that in Britain the use of cathode cores made of nickel with a low silicon content has avoided many of the difficulties due to interface troubles experienced in the United States and on the Continent of Europe, where a nickel of high silicon content has been used. The usual material in Britain is a pure commercial nickel with a low sulphur content and 0·05–0·10 per cent of magnesium as a reducing agent. In more recently developed types of valves, however, even the low quantity of silicon

present in pure nickel made it unacceptable for cathode cores, and a possible solution to the problem is the use of a 40 per cent tungsten–nickel alloy. Among the merits claimed for this is that a marked improvement in the ultimate strength can be obtained by a heat-ageing process which does not affect the ductility of the alloy. The low thermal conductivity of this alloy is also an advantage.

Grids in receiving valves are usually made by winding either fine molybdenum–tungsten or 5 per cent manganese–nickel alloy wire on to heavier supports of copper, nickel, alloys of these metals or nickel-plated iron. Molybdenum is, however, brittle and expensive; and it can cause poisoning of oxide cathodes if it becomes oxidized. On the other hand, 5 per cent manganese–nickel is not strong enough for many grids. Dr. Jenkins inquired as to the hope of a high-temperature nickel-alloy becoming available to ease this situation. For very fine grid wires, less than 0·001 in. in diameter, tungsten seems likely to be the only suitable material.

Other speakers referred to the difficulty experienced in preventing secondary emission from grids made of molybdenum and tungsten, and suggested that this might be overcome by gold-plating the helix wire; it is difficult, however, to obtain a non-porous plating and one which would still be satisfactory after the swageing of the grid to its support wires.

Receiving valves have relied mainly on envelopes of lime-soda glass, while those parts through which metal connexions are sealed are of lead glass. Increasing use is now being made, in cooled-anode transmitting valves, of the iron–nickel–cobalt alloy matched to a borosilicate glass: this is a very satisfactory combination in that the expansion match is correct over a wide range of temperature.

Probably the most important advance in the field of envelopes is in the use of vacuum-tight ceramics brazed to expansion-matching metals. Originally developed in Germany, this technique is being used extensively in the United States, and will undoubtedly be used in Britain for high-power valves for use at very high and ultra-high frequencies (30–3,000 Mc./s.) in the future. One other important material is pure copper for anodes of transmitting valves and for the blocks of magnetrons and klystrons. So far, it has been found essential to import the necessary high-quality copper; but it is much to be hoped that a satisfactory supply can be established in Britain.

Improvements in radio valves of all types are very dependent on new or improved materials; and this discussion should help towards obtaining these by encouraging co-operation between those engaged in fundamental research on materials, the suppliers of materials and the valve manufacturers.

R. L. Smith-Rose

PHYLOGENY OF THE BASIDIOMYCETES

UNDER this title, D. B. O. Savile (*Canad. J. Bot.*, **33**, 60; 1955) has contributed an essay in which he first of all sets out a series of "phylogenetic principles", thirteen in all, including some that are original and have a particular application to the fungi.

Each principle is enunciated and then discussed. The first of these may be cited as an example. "New major groups are never derived from climax groups of the parental stock, but always from unspecialized lower groups of great genetic plasticity; for it is only among the latter that revolutionary changes, usually fatal but occasionally a startling success, are to be expected." From this follows the author's second principle that, since new groups spring from plastic ancestral groups, most of the connecting links perish.

A further principle adopted by the author, though often viewed with caution by botanists, is the well-known one that ontogeny recapitulates phylogeny. That elaborate sexual mechanisms and self-sterility are, in general, of great antiquity appears to be borne out by primitive algæ and fungi. Parasitism is not to be regarded as a recent development.

His last principle states that, in cases of strict parasitism, the antiquity of the host reflects that of the parasite and *vice versa*, in that hosts and parasites evolve more or less together.

The application of these principles has led the author to the view that it is difficult to accept any starting point for the Basidiomycetes other than a primitive Ascomycete, very close to *Taphrina* and parasitic upon ancient ferns. The ancestral Basidiomycete gave rise to two main lines, one leading to the rust fungi; the other, by way of the parasitic Auriculariaceae, to the remaining Heterobasidiomycetidae and the Homobasidiomycetidae.

The second line has been characterized by a trend towards increasing saprophytic ability, increasing frequency of clamp connexions, and increasing complexity of fruiting body. The author's views as to the probable phylogenetic relationships are depicted in a number of diagrams. He is emphatic that the phenomenon of parasitism, far from being a recent development and derived from an antecedent saprophytism, is generally ancient in the fungi. The view is advanced that the Ascomycetes originated from parasitic, aquatic Phycomycetes. Saprophytism, in general, takes its place as a derivative condition from an antecedent parasitism.

WORLD CONGRESS OF MEDICAL PRACTITIONERS FOR THE STUDY OF PRESENT-DAY LIVING CONDITIONS

A CONGRESS of medical practitioners, representing thirty countries, was held in Vienna during May 23–25, 1953, with the object of studying present-day living conditions, and the report of the Congress has now been published*. The report begins with the opening address of the honorary president, Prof. E. Stransky, emeritus professor of neuropsychiatry in the University of Vienna, who accepted the honorary presidency on condition that its proceedings should be non-political; but he was compelled by ill-health to hand over the direction of the Congress to the president, Prof. P. Verga, director of the Institute of Anatomy and Pathological Histology of Naples, and director of the Cancer Research Institute in that city.

The main part of the report is divided into three parts: Part I is devoted to forty-two addresses given

* Reports and Proceedings of the World Congress of Doctors for the Study of Present-Day Living Conditions—Vienna, 23–25 May, 1953. Pp. xvi+384. (Vienna: Congrès Mondial des Médecins; London: Caversham Centre, 23 Caversham Road, N.W.3.) 10s. 6d.

on living conditions in various countries; Part 2 includes the twenty-one addresses given on various aspects of the effects of the Second World War on the physical and mental health of the peoples of a wide variety of countries; and Part 3, which deals with the duties of doctors faced by the problems raised, consists of sixteen addresses on these problems and discussions of them. All these addresses are given in English, French, German and Russian.

The report ends with the three conclusions of the Congress as follows: (1) The medical study of the relationships between improvements in living conditions and improvements in health should be developed; there should be special study of bad housing, lack of medical care, the incidence of tuberculosis, the infant death-rate and the effects of atomic and other forms of war on tuberculosis, mental illness and ill-health generally. (2) Doctors should not under any protext depart from their obligation to defend life and health, and they cannot separate individual treatment from problems of social means; for this the free and permanent exchange of ideas and therapeutic methods is necessary. (3) The work begun by the Congress must go on, and an international secretariat should be maintained to make the work of the Congress known, to keep the various countries in touch with one another and to prepare a second Congress.

EFFECT OF THERMAL SHOCK ON THE NUCLEIC ACIDS IN TOAD EMBRYOS DURING EARLY STAGES OF DEVELOPMENT

By H. HASEGAWA

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THE quantitative change in content of nucleic acids of amphibian embryos in the course of development has been studied by Brachet and other investigators. All their results are given as values per embryo. Thus quantitative patterns of nucleic acids during amphibian development are shown, while subject to experimental modification.

In view of the importance of the nucleic acids in embryonic development, I have tried to follow the changes of the nucleic acids, after thermal treatment of eggs, during the development of the toad embryo.

Some common Japanese toads, *Bufo vulgaris formosus* (Boulenger), were collected in the middle of March, and eggs were obtained from the uteri and inseminated artificially. 50 min. after insemination, the fertilized eggs thus obtained were transferred to hot water (33°, 35° and 37° C.) for 10 min. They were then cultured at room temperature (10–15° C.) and allowed to develop. The embryos were fixed at several desired stages of development with absolute alcohol, and were used as the experimental series for nucleic acid measurement. Out of forty-nine females (more than 6,000 eggs per female) three were used for obtaining eggs with the same amount of nucleic acid before fertilization as controls. The quantitative fractionation of the nucleic acids was carried out by the method of Schneider[1], and ribo- and deoxyribonucleic acid were measured photometrically by the orcinol reaction and diphenylamine reaction, respectively. A hundred embryos were used in one nucleic acid determination, and an average was taken of five experiments.

The quantitative changes of the nucleic acids at each stage of development of the eggs treated thermally are shown in Table 1. The ribonucleic acid content of control eggs did not increase until the blastula stage, but after that it increased remarkably. However, in the case of the eggs treated thermally, it was recognizable that the ribonucleic acid content slightly decreased immediately after treatment.

Afterwards, at the two-cell stages, the ribonucleic acid content decreased considerably after treatment at 37° C.; after this drop, it did not increase until the sixteen-cell stages. Then it began to increase rapidly,

Table 1. NUCLEIC ACID CONTENT (γ) DURING THE DEVELOPMENT OF EGGS SUBJECTED TO THERMAL SHOCK (per 100 embryos)*

Exp. stage	Control RNA	Control DNA	33° C. Treatment RNA	33° C. Treatment DNA	35° C. Treatment RNA	35° C. Treatment DNA	37° C. Treatment RNA	37° C. Treatment DNA
Before fertilization (egg)	581·3±1·24	66·9±0·28	581·3±1·27	66·9±0·26	581·4±1·25	66·8±0·24	581·2±1·28	66·9±0·22
After fertilization (egg)	—	—	580·2±1·33	66·8±0·29	578·3±1·22	66·8±0·27	575·6±1·31	66·9±0·27
2-cell stage	581·2±1·36	66·8±0·34	570·1±1·26	66·7±0·24	562·5±1·38	66·7±0·23	549·8±1·34	66·7±0·26
8-cell stage	581·4±1·21	66·8±0·26	570·4±1·37	66·8±0·31	562·3±1·40	66·8±0·31	549·4±1·31	66·7±0·26
16-cell stage	581·8±1·48	66·9±0·35	570·3±1·34	66·9±0·28	562·4±1·36	66·7±0·34	549·5±1·33	66·8±0·33
Morula	581·6±1·38	67·1±0·36	575·6±1·24	67·1±0·32	572·7±1·31	66·9±0·37	554·7±1·37	66·9±0·36
Blastula	581·4±1·33	69·4±0·42	578·6±1·32	69·3±0·35	576·6±1·42	68·5±0·28	562·6±1·42	68·1±0·41
Early gastrula	583·6±1·44	74·8±0·44	581·8±1·43	74·8±0·41	578·8±1·54	74·8±0·39	571·3±1·46	71·4±0·39
Gastrula	586·5±1·58	86·8±0·37	585·4±1·48	86·8±0·39	582·5±1·61	84·3±0·47	579·4±1·51	80·3±0·47
Neurula	590·8±1·63	124·6±0·43	588·6±1·49	124·6±0·43	588·4±1·53	121·4±0·46	586·5±1·47	116·7±0·51
Tail-bud stage	598·6±1·64	185·4±0·52	597·3±1·57	184·5±0·46	597·3±1·62	178·3±0·47	595·3±1·52	169·4±0·57

* Average of five experiments

Table 2. NUCLEIC ACID CONTENT (γ) IN EMBRYOS WHICH STOPPED DEVELOPMENT AT THE MORULA, BLASTULA AND GASTRULA STAGES DUE TO THERMAL TREATMENT (per 100 embryos)*

Exp. stage	Control RNA	Control DNA	33° C. Treatment RNA	33° C. Treatment DNA	35° C. Treatment RNA	35° C. Treatment DNA	37° C. Treatment RNA	37° C. Treatment DNA
Morula stage	581·6±1·38	67·1±0·36	570·1±1·42	66·9±0·31	568·1±1·35	66·9±0·28	550·8±1·42	66·9±0·37
Blastula stage	581·4±1·33	69·4±0·42	573·2±1·38	67·1±0·34	570·8±1·51	66·8±0·36	556·8±1·48	66·8±0·39
Gastrula stage	586·5±1·58	86·8±0·37	577·3±1·46	70·4±0·33	572·3±1·47	67·4±0·35	564·8±1·51	67·1±0·35

* Average of three experiments

and at the tail-bud stages it reached nearly the normal ribonucleic acid content.

The increasing ratio of the ribonucleic acid content, which had decreased after the sixteen-cell stages, was greatest after the treatment at 37° C., at which it showed the greatest decrease.

The deoxyribonucleic acid content of the control eggs did not change until the morula stage; but it increased remarkably after that. That of eggs treated thermally, in contrast to the ribonucleic acid content, did not decrease after the thermal treatment. It increased considerably in the cases of both the control eggs and the eggs treated thermally after the morula stage; but the increase in embryos receiving treatment at 35° C. and 37° C. was a little less than in the control eggs.

The embryos which stopped developing at the morula, blastula and gastrula stages, due to the thermal treatment, lost both their deoxyribonucleic acid and their ribonucleic acid to a much greater extent than those which did not stop growing. The deoxyribonucleic acid content especially decreased greatly.

From these results it is clear that the deoxyribonucleic acid content of the fertilized eggs of the toad is scarcely influenced by development, but that the ribonucleic acid content shows a remarkable decrease. The change of the latter in eggs treated thermally is similar to the change of nucleic acid content which Steinert[2] discovered after heat-treatment of the early embryos of *Amblystoma*. The change of nucleic acid content of the control eggs is nearly identical with the results obtained by Hoff-Jørgensen[3] with *Rana temporaria*, Sze[4] with *R. pipiens*, and Steinert[2] with *R. fusca*.

The decrease of the ribonucleic acid content of the developing embryos after thermal treatment is considered to be brought about by the destruction of cytoplasmic granules (ribonucleoprotein granules) by temperature shock[5], and its increase after the sixteen-cell stage by the resumption of formation of ribonucleic acid[2]. From the fact that the decrease of the ribonucleic acid content in embryos in the tail-bud stage was not recognized when they were treated at 33° C., but was seen after treatment at 35° and 37° C., treatment at 33° C. seems to have no influence in the tail-bud stage; but treatment at 35° and 37° C. continues to affect the following stages of development.

I thank Dr. T. Yamada, Nagoya University, for valuable criticism.

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THE HUMAN INTERVERTEBRAL DISK

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AND
A. NAYLOR
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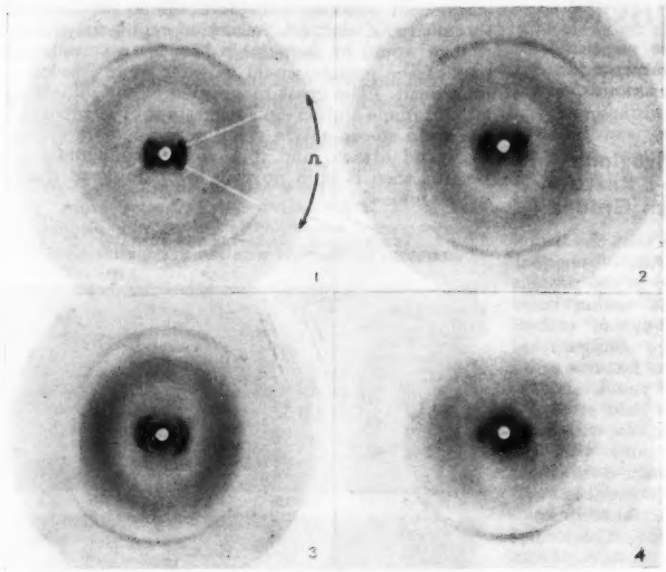
In earlier experimental work on the structure of the human intervertebral disk, various conclusions were drawn from experiments carried out on partially dried specimens of various ages[1]. It is clear that a truly systematic investigation of this problem is difficult because of the obvious impossibility of obtaining specimens other than of a morbid anatomical origin. In consequence, many key experiments have had to be postponed until the necessary specimens were available, and this has retarded our publication of results.

It has now been possible to supplement most of our original work by observations on specimens after freezing. These were sectioned and mounted on the spectrometers of a high-output X-ray tube and photographs obtained with an exposure of ½–1 hr. This method gave an X-ray diagram which we feel may be more comparable with that from an *in vivo* specimen, as the loss of water is comparatively negligible. Examinations of certain of the specimens have been carried out using the polarizing microscope, and information has been obtained which has been readily correlated with the X-ray evidence.

In our early paper on the very young nucleus, we identified Debye–Scherrer lines on the X-ray diagram, the most intense of which (~ 2·85 A.) may have been a polar spacing of the collagen diagram. This and the diffuse and disoriented character of the low-angle scatter (10–50 A.) suggested one of two possibilities: (*a*) there may be additional crystalline components in the material of the disk other than collagen; or (*b*) the collagen chains were aligned to form highly swollen crystallites in which the only clearly defined spacing was that along the fibre axis. It is now clear that the former hypothesis is the more acceptable, as the sample we originally used and photographed after ageing for some time has shown that the main additional reflexions can be identified as those from sodium chloride. Further, the Debye–Scherrer lines have developed a discontinuous appearance typical of a powder of an inorganic salt, whereas originally they were broad and continuous. From this result, which was verified by other observations, it appears that in the nucleus of the very young disk—up to approximately two years—there is a salt content which tends to decrease with age and which does not show on the X-ray diagram after about two years of age. This matter is a subject of further study at the present time.

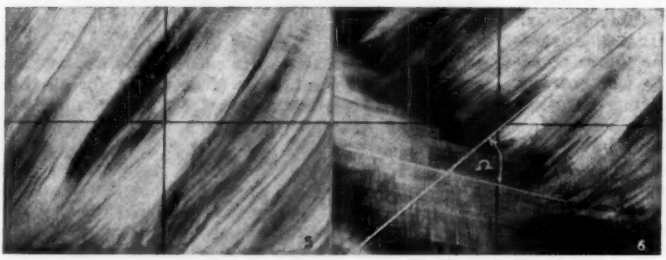
The second series of observations which appear of importance show the striking difference between the results obtained on specimens with a normal *in vivo* water content and the partially dried specimens of our earlier investigations. We were able to direct attention to this possibility towards the end of our original paper, but the differences are even more marked than we suspected at that stage.

In the first place, the cross-banded structure appears in the human disk at a much earlier age than that indicated by our original measurements. From an extensive series of observations, we feel that there is considerable resolution of the biaxial orientation in early adolescence, and that some biaxial orientation



(1) Annulus fibrosus, age 25 years. Specimen *in vivo* condition showing biaxial form of collagen fibrils. (2) Annulus fibrosus, age 25 years. Specimen partially dried and showing inhibition of the biaxial arrangement. (3) Annulus fibrosus, age 25 years. Specimen air-dry, showing equatorial arcs coalescing into a single arc around equator of fibre. Diagram with large angular dispersion. (4) Annulus fibrosus, age 63 years. Single sliver teased from the wall of the disk. Fibre axis probably tilted with respect to specimen axis as the 4·0 A. and 2·86 A. meridional reflexions on one side of the diagram are very weak

Photographs were obtained using copper *Ka* radiation. Specimens of the annulus fibrosus were mounted so that the X-ray beam was perpendicular to the spinal axis and parallel to the radial direction of the disk



(5) Photomicrograph using polarized light showing the uniaxial orientation of the fibrils (see Fig. 4). (6) Photomicrograph using polarized light showing the biaxial orientation of the fibrils. The mutual orientation of the fibrils is at an angle of Ω in the plane of the disk wall. This orientation is also shown by the angle Ω between the equatorial reflexions in the X-ray diagram of Fig. 1

may be present in the annulus of the very aged disk. In our earlier work with partially dried specimens, we were able to demonstrate a biaxial structure only in middle-aged disks. To clarify this apparent discrepancy between *in vivo* and air-dried specimens, an annular specimen was photographed during drying, and it was clearly shown that in the younger specimens the biaxial character of the orientation was inhibited by the drying process. Figs. 1, 2 and 3 show the disorientation process occurring on drying in a disk of age twenty-five years. It is interesting to consider the reasons for such processes, and it is possible that the wall distortion on drying is greater in the younger disks where the absorbed water in the inter-fibrillar matrix is greater than in the more crystalline and collagenous structures of the older disks. It has now been possible, on air-drying the latter specimens, to show a wall structure in which the equatorial arcs have not fused together and a biaxial arrangement of the collagen fibrils is retained.

Having established this type of X-ray diagram from the wall of the annulus fibrosus, it is possible that the diagram may arise from one of two distributions of the collagen in the disk wall. It may be arranged in superimposed flat sheets distributed around the wall as previously described, or the crystallites may be in a helical form. It is, however, fairly certain that the former is the more likely structure, as a technique of sectioning has been developed in which individual sheets of collagen can be dissected from the disk; these have a uniaxial arrangement when viewed in a polarizing microscope and give a highly oriented and crystalline collagen diagram when examined by X-rays. This structure is shown in Fig. 4, and it can be seen how similar the diagram is to that of highly orientated rat-tail tendon. Fig. 5 is a polarizing microscope photograph of such a specimen showing single striations in the wall, and Fig. 6 is one from the same disk in which the biaxial orientation of the collagen sheets can be clearly seen, and in which the fibrils have a mutual orientation of Ω in the circumference of the disk. An X-ray photograph of a similar specimen gave a biaxial diagram as in Fig. 1.

In the nucleus pulposus a study is being made of the possible presence of components other than collagen in samples dried in a desiccator. Here, reflexions which are not characteristic of the collagen pattern or of common salt have been obtained on X-ray diagrams of such materials.

Although this communication is only a brief survey of the present trend of our work, it is important that the results obtained from the dried specimens of intervertebral disk should be considered in their proper perspective, because although we felt that in our earlier work the *in vivo* specimens would be different from the partially dried samples, such wide differences of structure were rather surprising. A more detailed account of this work will be published in due course elsewhere.

This work forms part of a scheme of fundamental research on the structure of fibrous proteins being carried out in the Bradford Technical College. One of us (W. G. H.) is indebted to the Bradford Education Authority and the Bradford Group 'A' Hospital Management Committee for a joint scholarship to carry out this work. [Dec. 22

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Thermodynamic Data for Myoglobin, Hæmoglobin and Cytochrome-c Reactions, and the Position of the Hæm Groups

Conant[1] first put forward the idea that the hæms in hæmoglobin are held by two bonds of unequal strength between the iron and groups in the protein on both sides of the hæm disk, the weaker bond breaking when combination with oxygen, carbon monoxide, etc., occurs. This crevice configuration has been elaborated to explain various features of its reactions by Coryell and Pauling, Wyman, and St. George and Pauling; but Keilin has laid stress on other aspects, particularly the combination with large molecules such as nitrosobenzene and 4-methyl imidazole, which suggest that the hæm iron is not embedded in a crevice but is readily accessible[2].

Unfortunately, few of the experimental techniques which give direct quantitative evidence on molecular configuration are applicable to hæmoproteins. From a study of unit-cell dimensions in crystals of met-myoglobin and its 4-methyl imidazole complex, Kendrew and Parrish[3] conclude that the hæm group is more likely to be located on the surface than in a deep crevice. No similar data are available yet for methæmoglobin. But information relating to the crystalline state, valuable as it is, does not necessarily give a true picture of the configuration of such large molecules in aqueous solution, the medium in which their reactions have almost exclusively been studied, and one which is more strictly comparable to their environment *in vivo*. On the other hand, a comparison of thermodynamic data for corresponding hæmoprotein reactions, especially the entropy changes, does offer a basis for judging to what extent the changes in configuration which accompany the reactions are similar, and hence for judging to what extent the actual configurations of the hæm groups are also similar, when the molecules are in solution.

Fortunately, there is no doubt that the hæm in cytochrome-c is bound in a crevice. It reacts extremely slowly, if at all, with the usual ligands between *p*H 4 and 11, and its spectroscopic and magnetic properties show the hæm to be bonded as in a hæmochromogen, where the fifth and sixth co-ordination positions of the iron, on either side of the hæm, are occupied by nitrogenous substances[4]. The thermodynamic data for its reactions can therefore be taken as characteristic of hæm in a crevice configuration. There is a very great contrast between the data for cyanide-complex formation by ferricytochrome-c and ferrimyoglobin, as shown in Table 1[5,6]. Although the affinities (free-energy changes) are quite similar, the ferrimyoglobin reaction is greatly favoured by the change in heat content, yet the entropy change is very disadvantageous; whereas the ferricytochrome-c reaction is even slightly endothermic and its complex forms entirely by virtue of the very favourable entropy change. This kind of contrast is just what would be expected if the hæm were in a crevice in cytochrome-c and relatively exposed on the surface in myoglobin. In the former case, energy would be required to break the bond to the more weakly held amino-acid residue, thus diminishing the net exothermicity of complex formation; but the entropy change would be favourable because a considerable part of the protein would gain far more freedom of movement. The great magnitude of the differences, 20 kcal./mole and 55 e.u., suggests that in myoglobin the sixth co-ordination position is far more exposed to ligand attack, and if a crevice configuration is present then it is in no way comparable to that in cytochrome-c.

Table 1. Thermodynamic Data for the Formation of Cyanide Complexes by Reaction with the Cyanide Ion, at 25° C.

	ΔG° (kcal./mole)	ΔH° (kcal./mole)	ΔS° (e.u.)
Ferrimyoglobin	− 11·4	− 18·6	− 24
Ferricytochrome-c	− 8·3	+ 1·1	+ 31·3
Differences:	− 3·1	− 19·7	− 55·3

Table 2. Thermodynamic Data for Ferrimyoglobin (MetMb) and Ferrihæmoglobin (MetHb) Reactions, at 25° C.

Reaction		ΔG° (kcal./mole)	ΔH° (kcal./mole)	ΔS° (e.u.)
Complex formation with OH^-	MetMb	− 6·9	− 7·7	− 2·6
	MetHb	− 7·1	− 9·5	− 7·9
Complex formation with F^-	MetMb	− 2·0	− 1·5	+ 1·8
	MetHb	− 2·4	− 2·5	− 0·6
Reduction by H_2 (standard cell reaction)	MetMb	− 2·7	− 13·7	− 37·0
	MetHb	− 3·6	− 15·2	− 39·0

Results for the cyanide reaction of ferrihæmoglobin are not yet available, but a comparison with ferrimyoglobin is possible for three other reactions as shown in Table 2[6-8]. These results, like those in Table 1, refer to highly purified hæmoprotein preparations; with ferrihæmoglobin, hæm–hæm interaction was completely absent since hyperbolic and not sigmoid dissociation and titration curves were obtained. The great similarity between the results, which differ at most by only 1·8 kcal./mole in ΔH° and 5·3 e.u. in ΔS°, suggests very strongly that the hæm is very similarly situated in both hæmoproteins in this purified condition. If anything, for all three reactions the entropy changes are less favourable for ferrihæmoglobin and the change in heat content more favourable; so, in view of the above comparison with ferricytochrome-c, ferrihæmoglobin shows to an even less extent than ferrimyoglobin the characteristic behaviour of hæm situated in a crevice.

A discussion of hæm–hæm interaction in relation to the entropy changes in hæmoprotein reactions and those with inorganic co-ordination complexes is being published elsewhere[9].

The work reported above forms part of a research programme supported by grants from the Medical Research Council and the Nuffield Foundation which we gratefully acknowledge.

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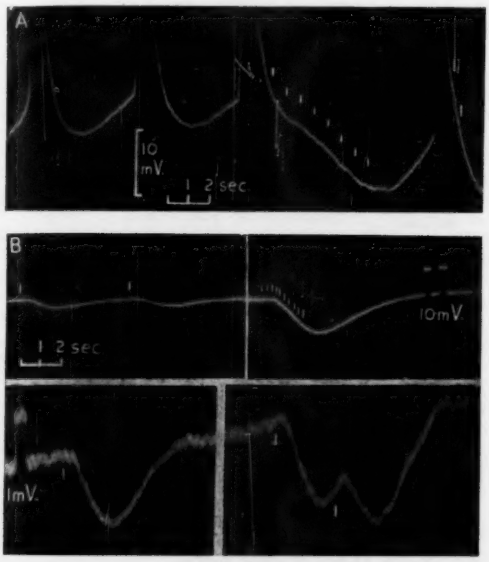
Production of Membrane Potential Changes in the Frog's Heart by Inhibitory Nerve Impulses

THE observations reported here were made in the course of preliminary experiments concerned with the electrical changes which vagal and sympathetic nerve impulses produce in the pace-maker region of the heart. The preparation was the sinus venosus of the frog together with its nerve supply (one or both vagi; more recently, the intra-cranial roots and sympathetic components of the vagus were prepared for separate stimulation). A micro-electrode was used for intracellular recording of the membrane potential, the electrode being introduced into the sinus through the exposed sino-auricular ostium or through the cut inferior vena cava. Although the nervous control of the heart is not restricted to its pace-maker region, we were especially interested in the mechanism by which nerve impulses regulate the beat frequency, and an attempt was therefore made to place the recording electrode as close as possible to the point of origin of the rhythmic activity. This place can be recognized by the appearance of a slow depolarization preceding each action potential[1,2], and the accompanying records were obtained from such regions.



Intracellular recording from the sinus venosus of the frog's heart. Single stimuli to the vagus are indicated by white dashes. Depolarization is signalled by upward deflexion of trace. Note: slow spontaneous depolarization precedes the spike potential; vagal impulses are followed by transient hyperpolarization

In (*A*), the recording electrode had been inserted into an active part of the sinus, beating at a rate of about 12 per min. The highest level of the membrane potential, in the interval between the action potentials, was about 50 mV. After the third beat, a series of stimuli (indicated by dashes) were applied to the vagus, causing an increase of the membrane potential (downward displacement of the trace) accompanied by a stoppage of the beat. After the end of the vagal stimuli, the membrane potential fell and another impulse arose.

In (*B*) and (*C*), the effects of single and repetitive vagal shocks are shown during a state of arrest of the heart produced by a preceding burst of inhibitory impulses. Each shock is followed, after a latency of about 0·5 sec., by a transient increase of the membrane potential reaching a peak in about 1·5–2 sec. and lasting 5–7 sec. (16° C.). The amplitude of the effect varied greatly; it depended, among other influences, upon the position of the recording electrode and the timing of the stimulus. For example, at the start of record *C*, the slow local depolarization of the arrested pace-maker region had been allowed to proceed towards a level at which renewed beats were about to occur. A single shock was then applied to the vagus (first dash), stopping the depolarization process and increasing the membrane potential by several millivolts. The next few shocks contributed rather less and only served to maintain the average level of the potential; to obtain a further substantial increase, it was necessary to fire a series of impulses in rapid succession. After this, depolarization was again allowed to develop, this time to a point at which a new action potential arose. The largest hyperpolarization so far obtained during a burst of vagal impulses amounted to 33 mV. (raising the membrane potential from 50 to 83 mV.).

In the experiment illustrated here, the mixed vagal nerve ('vago-sympathicus') was stimulated, and this may have resulted in some complication. Thus, the obvious enhancement of the 'post-vagal' spike and its lowered firing threshold (in *A* and *C*) may have been due, in part, to a delayed action of sympathetic impulses (as was found to occur in other experiments in which the component nerves were stimulated separately). However, the hyperpolarization which accompanies the immediate inhibitory effect was confirmed when the intracranial vagal roots were excited alone. These observations agree well with the classical, but sometimes disputed, findings made by Gaskell[3] on the quiescent auricle of the tortoise, namely, the occurrence of a positive variation of the injury potential during excitation of the inhibitory nerve fibres of the heart.

This work was supported by a grant made by the Nuffield Foundation.

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Development of Fertilizing Capacity of Rabbit Spermatozoa in the Uterus

By deposition of sperm into the Fallopian tubes of a rabbit at various times before or after ovulation, it has been found[1] that ejaculated or epididymal spermatozoa require about six hours stay in the tubes to acquire their fertilizing capacity. Although sperm incubated in the uterus of a live animal for five hours was found to be capable of fertilization when deposited into the tube, the time requirement in the uterus was not systematically determined. The following experiment provides more direct evidence to show that spermatozoa placed in the uterus also require a definite period of time to develop their fertilizing capacity. However, attempts to develop the fertilizing capacity of ejaculated sperm *in vitro* have been unsuccessful.

The uterine spermatozoa were obtained by centrifugation of saline washings of rabbit uteri at various times after two fertile matings. They were then transferred into Fallopian tubes where recently shed ova were present. Doe rabbits were injected intravenously with sheep pituitary extracts to induce ovulation, which occurs about ten hours later. At 11½–12½ hours after injection, flank incisions were made under 'Nembutal' anæsthesia and about 0·03–0·06 ml. of the centrifuged uterine sperm suspension was deposited into each tube through the infundibulum. The concentration of spermatozoa was estimated and the number of spermatozoa deposited into each tube was calculated. One day after operation, the rabbits were killed and their tubes were flushed with saline to recover ova which, if fertilized, would be at about the 8-cell stage. The ova thus recovered were mounted in saline on a slide under a cover slip. They were examined under a compound microscope before fixation, after fixation with acetic alcohol, and again after being stained with acetic lacmoid[2] in order to make certain that cleaved ova were fertilized.

It is quite clear from Table 1 that fertilization failed when deposited spermatozoa were ejaculated, epididymal, or recovered from the uterus 2–4 hr. after mating. The percentage of fertilized ova, however, increased from 38 to 77 per cent when the deposited spermatozoa were recovered from the uterus of a rabbit 6–16 hr. after mating. Since the fertilizing capacity of spermatozoa is lost after thirty hours in the female tract[3], the relatively low percentage of fertilized ova (56 per cent) resulting from the deposition of 24-hr. uterine sperm is therefore to be expected.

Deposition of ejaculated sperm either incubated at 38° C. or stored at 10° C. for 2–16 hr. in saline, in saline containing an equal volume of rabbit serum, or in saline containing Chicago blue or Congo red which induces sperm agglutination, or deposition of fresh ejaculated sperm suspended in saline containing tryptophan, glutamic acid, thiamine, ascorbic acid, glutathione, succinic acid, fructose or glucose all failed to effect fertilization. Deposition of sperm incubated at 38° C. or stored at 10° C. in uterine washings in the presence of endometrial scrapings or in the lumen of an excised uterus for 12–16 hr. also failed to effect fertilization except in two doubtful ova out of a total of 139.

The total number of spermatozoa recovered from both the uteri of a rabbit mated at least twice by fertile males (at least 300 million spermatozoa ejaculated into the vagina) was extremely low, ranging from 0·38 to 4·2 million, and the highest count was obtained from the uteri of rabbits 12 hr. after mating. The difference in the proportion of fertilized ova among groups is, however, not related to the total number of sperm deposited into each tube. Nevertheless, it is quite possible that the percentage of fertilized ova may be related to the number of sperm within any one group.

Table 1. Development of Fertilizing Capacity of Rabbit Spermatozoa in the Uterus

Sperm deposited	No. of rabbits	No. of sperm deposited into each tube (range)	Ova recovered		Percentage of ova fertilized
			Total	Fertilized	
Uterine (hr. between mating and recovery)					
2	7	30,000–46,000	73	0	0
4	8	20,000–198,000	86	0	0
6	8	40,000–116,000	69	26	38
12	11	20,000–180,000	117	63	54
16	5	27,000–630,000	65	50	77
24	5	25,000–57,000	55	31	56
Epididymal Fresh, centrifuged	5	80,000–1,400,000	52	0	0
Ejaculated Fresh, centrifuged	8	630,000–8,800,000	107	0	0
In various solutions for different times	17	15,000–1,230,000	274	0	0
Incubated or stored in uterus fluid, endometrium, or in excised uterus	12	154,000–1,640,000	139	2?	0

The ova fertilized by tubal insemination are capable of developing into normal young, since normal fœtuses were obtained from animals receiving 6-, 12- or 24-hr. uterine sperm.

The failure of fertilization in the deposition of ejaculated, epididymal, or 2-4 hr. uterine sperm is mainly due to the failure of spermatozoa to penetrate into the zona pellucida, because all the unfertilized ova had 1–30 or more spermatozoa on the surface of the zona pellucida but not one penetrated into the perivitelline space. The failure of fertilization of some ova after deposition of 12- to 24-hr. uterine sperm is probably due to the absence of spermatozoa in the vicinity of ova before the ova lost their fertilizability, since fertilizability of rabbit ova after ovulation is only 6–8 hr.[3,4] at the most.

In the previous study[1], a high proportion of fertilized ova was obtained when 5-hr. uterine sperm was deposited in the tubes of rabbits 2 hr. before ovulation, but a low proportion of fertilized ova was obtained when the same sperm was deposited into the tubes of rabbits 2 hr. after ovulation. This is probably due in the former case to the partial development of fertilizing capacity in the uterus first, which was completed later in the tube before the loss of fertilizability of the ova; and, in the latter case, to the loss of fertilizability of the ova before the attainment of fertilizing capacity by the sperm. Furthermore, it was mentioned[5] that the percentage of fertilized ova was lower when the deposited sperm was incubated in the uterus of a live animal for a shorter time, 2 hr., than for a longer time, 6 hr. In that experiment, the uterine sperm was deposited 2 hr. before ovulation, in which case there is still

a chance for the sperm to complete the process of development in the tube. In the present study, rabbits 2 hr. after ovulation were used and no fertilization was observed, even if the deposited sperm was recovered from the uterus 4 hr. after mating. This is probably due to the loss of fertilizability of ova before the completion of fertilizing capacity in the tubes. These results indicate that the development of fertilizing capacity of sperm can be partially achieved in the uterus and then completed in the tubes.

That the spermatozoa must spend some time in the Fallopian tubes before they are capable of fertilization has also been demonstrated by the deposition of sperm in the tubes of rabbits or into the peri-ovarian sac of rats[6], by the examination of the number of spermatozoa about the ova and the number of penetrated ova in the rat[7], and by the examination of the number of penetrated ova after delayed mating in the rabbit and in the rat[8]. This is, however, the first experimental demonstration of the development of fertilizing capacity in the uterus. The fertilization of mammalian ova *in vitro* has never been conclusively demonstrated[6,9,10]. Since the demonstration that spermatozoa require a certain length of time in the female tract to attain their fertilizing capacity[1,6], the fertilization of rabbit ova *in vitro* by means of sperm recovered from the tubes of a rabbit 12 hr. after mating was achieved[11], and the penetration of spermatozoa into rabbit ova cultured in the utero-tubal secretion containing spermatozoa was also reported[12]. It is quite clear from the present direct evidence and the recent contributions by other workers that the spermatozoa require a certain length of time either in the uterus or in the Fallopian tubes to develop their fertilizing capacity. Biochemical aspects of the developmental process in the female tract are under investigation.

This work has been aided by grants from the Josiah Macy Jr. Foundation and the Population Council. Thanks are due to Miss Faith Andrews for assistance and to Dr. G. Pincus for his interest.

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Effect of Triethylene Melamine on the Fertility of Rats

Observations made during the course of investigations into the effect of prolonged treatment with triethylene melamine on the growth of the Walker carcinosarcoma[1] have led to the observation that this drug produces a selective effect on the male reproductive system and the early embryo.

Table 1. Effect of Continued Treatment with Triethylene Melamine on the Fertility of Male Rats
All the females used were known to be fertile, and fresh groups were introduced for each breeding test. The figures marked * are results from mating the five treated males with ten females as a group; the remainder are from isolated matings. The failure in the control series was due to the persistent infertility of one male

Dose (mgm./kgm.)	Treatment	Mating periods (days from zero time)	Number of litters	
			Treated	Controls
0·2	21 doses in all, given as five daily doses initially and twice-weekly the remainder The course ended on day 57	16–38	0/10*	10/10*
		58–65	0/5	4/5
		72–80	0/5	4/5
		90–98	0/5	4/5
		105–122	0/5	4/5
0·05	41 doses given in a period of 57 days	16–38	0/10*	10/10*
		58–65	0/5	4/5
		72–80	0/5	4/5
		90–98	3/5	4/5
		105–122	4/5	4/5

Continued administration of triethylene melamine to male rats has shown that 0·05 mgm./kgm. daily is effective in producing and maintaining sterility in 100 per cent of animals, while a similar result is obtained by the less-frequent injection of 0·2 mgm./kgm. (Table 1). In males receiving the lower dose, sterility persisted for three to four weeks after cessation of treatment; those given the higher dose (0·2 mgm./kgm.) have continued to remain sterile up to the time of writing (eight weeks). In the entire period of infertility, both during and after treatment, these animals produce spermatozoa and regularly impregnate the females with which they are mated. Short courses of treatment, for example, 0·2 mgm./kgm. daily for five days, produce periods of sterility lasting for a few weeks. 24 hr. after a single dose of triethylene melamine (0·2 mgm./kgm.), isolated matings were successful during a period of four days. Fresh females introduced to the same males six days after the treatment did not produce litters, although insemination occurred. These results suggest that the drug does not interfere with the function of mature spermatozoa, but only with those formed after treatment. A detailed examination of the action of the compound on spermatogenesis is in progress.

The fertility of adult female rats was unaffected after a short course of triethylene melamine (0·2 mgm./kgm. daily for five days). The same treatment commencing on the fourth day after mating with a similar number of untreated males resulted in a complete failure to produce litters. In identical control series, litters were obtained from every animal.

It seems certain that these actions of triethylene melamine are due to a direct effect on the reproductive system, and that the amount of drug involved is very small. Since virtually nothing is known about the mode of action of ethyleneimines as tumour inhibitors, the selective interference by triethylene melamine with the reproductive process is interesting. The dose-levels used produced no obvious signs of toxicity, apart from interference with gain in weight. Hendry, Homer, Rose and Walpole[2] refer briefly to the histological appearance of the rat testis following a single lethal dose of triethylene melamine by the intraperitoneal route. The effects were stated to range from "loss of spermatogenesis with cell desquamation in a few tubules only, to complete atrophy". The carcinogenicity of this compound has also been demonstrated in rats[2], but no undesirable effects have been manifest in any of our treated animals, although some have now been kept for one

year from the period of treatment. The ability of other anti-tumour agents to interfere specifically with male fertility is being investigated. Full details of this work will be published elsewhere.

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Polyspermy after Induced Hyperthermia in Rats

It was reported earlier[1] that the incidence of polyspermy in rats increased about seven times if coitus were not permitted at the normal time but delayed until after ovulation. When coitus occurred between 8 and 10 a.m., nearly 9 per cent of the eggs became polyspermic, whereas after normal mating only a little more than 1 per cent were polyspermic. These results were obtained in Sydney, Australia, with rats of an albino type.

Recently, the attempt was made to repeat these observations in London, and for the purpose two strains of laboratory rat were used: an albino and a 'hooded' strain. In spite of almost daily trials extending over a period of two months with the albino rats, delayed mating occurred at only two out of about 150 opportunities; neither of these rats yielded polyspermic eggs. The hooded female rats were more willing to perform coitus after ovulation; but even these mated much less readily than did the rats used in Sydney. Moreover, the incidence of polyspermy, as seen in 428 eggs from thirty-six hooded rats, was only 2·2 per cent. As a control group of thirty rats, allowed free mating, gave an incidence of 1·9 per cent, it was apparent that, in contrast to the Sydney results, the frequency of polyspermic fertilization had been virtually unaffected by delaying coitus until after ovulation.

It is tempting to ascribe the regional differences in willingness to mate belatedly, and in the incidence of polyspermy, to differences in strain characteristics of the rats used. However, evidence has now been obtained which indicates that environmental differences may also have been responsible: a high environmental temperature has been found to have a profound effect on the block to polyspermy.

Observations were made on ten hooded rats. Immediately after delayed mating, each rat was kept for about six hours in an electrically heated box, and heating was controlled so as to maintain the animal's body temperature a few degrees above the normal level of about 38·5° C. Box temperatures ranged from 35° to 42° C. The mean of the body temperatures of the rats during the heating period was 40·6° C. and the mean maximum temperature reached was 42·1° C. On slaughter the following day, a total of 109 eggs was recovered. There were ninety-one sperm-penetrated eggs, and eighteen, or 19·8 per cent, of these were polyspermic, including three tetraspermic eggs and one pentaspermic egg. Moreover, the results showed that, of all the eggs that theoretically could have become polyspermic (because two or more sperms had passed through the zona pellucida), 75 per cent actually became polyspermic.

In the rats used, therefore, a readily tolerated hyperthermia exerted a powerful inhibitory action upon the development of the block to polyspermy. The effect was similar to, but rather more striking than, that observed after the local application of a 'hot-shock' to the eggs in the Fallopian tube[2]. Consequently, it seems possible that changes in body temperature even within the normal physiological range may have a perceptible influence upon the reactions of the egg to sperm penetration. Investigations are continuing on the effects of variations in body temperature on fertilization, and a full report will be made later.

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Chromosome Aberrations caused by Radioactive Thymidine

Chromosome aberrations in onion root tips treated with 2-^{14}C-thymine deoxyriboside (thymidine) and with 2-^{14}C-thymine have been studied. It has been found that radioactive thymidine gives a significantly higher frequency of aberration than equivalent amounts of radioactive thymine. Since thymidine is a precursor of deoxyribonucleic acid thymine[1,2] and becomes a part of the deoxyribonucleic acid structure without diversion to any known cytoplasmic component including ribonucleic acid, a unique system is available for provoking intranuclear damage. Thymine, on the other hand, is not incorporated into deoxyribonucleic acid[2,3]. Its radiation effects, therefore, have been studied because it enters the cell without becoming a part of deoxyribonucleic acid and thus provides a source of radiation outside the deoxyribonucleic acid molecule.

2-^{14}C-Thymidine was prepared by enzymatic reaction of 2-^{14}C-thymine with deoxyribose-1-phosphate[4]. The thymidine thus obtained, like the parent thymine, had a specific activity of 3 microcuries per micromole.

Seeds of *Allium cepa* were germinated, and placed on filter paper so that the rootlets were in contact with radioactive solutions. The root tips were stained according to the Feulgen technique, smeared, and late anaphase and early telophase cells were scored for the presence of fragments and bridges. Scoring was on the basis of percentage of aberrant cells rather than aberrations per cell. A count of cells with one or more micronuclei was made for all but a few of the root meristems studied. All root tips were coded, so that the nature of the treatment was unknown to the scorer.

A 19-hr. exposure to radiothymidine was more effective in causing chromosomal aberrations than a similar treatment with radiothymine (Table 1). Controls (water, non-radioactive thymidine, non-radioactive thymine) showed much less chromosomal damage.

The frequency of aberrant cells did not increase significantly with exposure to ^{14}C-thymidine for periods up to 12 hr.; after 12 hr., radiation damage increased markedly with exposure, whereas increasing exposure to ^{14}C-thymine was not so effective (Table 2).

Since thymidine was incorporated into deoxyribonucleic acid and not into ribonucleic acid, a con-

Table 1

Treatment*	Cells scored	Aberrant cells (per cent)	Av. No. of cells per meristem with micronuclei
Radiothymidine	1,093	8·41	54·1
Radiothymine	1,084	2·12	11·3
Water	1,021	0·68	4·6
Non-radioactive thymidine	330	1·21	5·0
Non-radioactive thymine	264	1·13	7·4

* All components were present at a final concentration of 0·42 μM per ml. of water.

Table 2

Treatment (hr.)	Cells scored	Aberrant cells (per cent)	Av. No. of cells per meristem with micronuclei
Radiothymidine, 0·42 μM per ml. (1·26 μc. per ml.)			
4	329	2·13	5·1
8	292	2·40	13·1
12	311	2·57	15·1
16	201	5·47	26·5
20	211	14·22	61·3
24	222	15·77	83·6
28	240	13·33	107·4
30	188	20·74	135·3
Radiothymine, 0·42 μM per ml. (1·26 μc. per ml.)			
26	319	3·13	24·4
28	253	1·98	30·2
30	279	4·66	26·6

venient method for determining radioactivity in the former per root tip was provided. Feulgen-stained meristems, previously treated with ^{14}C-thymidine or ^{14}C-thymine for 19 hr., were smeared on copper planchets, flushed with 70 per cent alcohol and assayed in an internal flow counter. Meristems treated with radiothymidine assayed an average of 455 counts per min., in contrast to 39 counts per min. for meristems treated with radiothymine.

It is clear that radioactive thymidine causes chromosome aberrations which increase in frequency with increased exposure. This appears to be correlated with the unique localization of radioactivity in the thymine of deoxyribonucleic acid. Additional biochemical–cytological studies are now in progress; it is hoped that from these studies it may be determined whether the chromosome breaks are caused chiefly by discharges in the deoxyribonucleic acid or by β-particles from an extra-chromosomal source.

This work was supported in part by grants from the American Cancer Society.

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Creatine–Creatinine Metabolism in Radiation Myopathy

Muscular weakness is one of the well-known clinical sequelæ of exposure of mammals to ionizing radiation. The degree of myasthenia is determined by the radiation dose to which the individual has been exposed. The present report deals with observations which may give a clue to some of the biochemical mechanisms underlying this radiation-induced myopathy.

Concurrent with studies designed to measure radiation-induced tissue breakdown in rats exposed to 756 r. of total-body X-radiation, total amount and specific activity of the urinary creatine and creatinine was measured in animals loaded with glycine-2-^{14}C for eight days prior to irradiation. Each of ten rats, weighing about 190 gm. at the beginning of the experiment, was injected intraperitoneally with a daily dose of 2 ml. (337 μgm.) of glycine-2-^{14}C giving 337,280 counts/min. for a period of eight days, that is, a total dose giving 2,698,240 counts/min. Eight hours after the last injection, six of the animals were exposed to 756 r. of 250 kV. X-rays (*L.D.* 75/30 days). Immediately afterwards, each rat was given an intraperitoneal injection of 10 mgm. benzoic acid in 10 ml. of 0·9 per cent sodium chloride. The rats were placed in individual confining cages and urine was collected for 24 hr. after exposure. An additional 10 mgm. of benzoic acid was given at this time, and the urine output of the second 24-hr. period was collected.

Creatinine and creatine were determined according to the method of Stelgens[1]. The carbon-14 activity of total creatinine was measured by counting the activity of the appropriate area on Whatman filter paper No. 1 after conversion of creatine to creatinine and chromatography in a solvent-system consisting of butanol saturated with water[2]. The amount and activity of hippuric acid were determined according to a previously published method[3].

As a result of the loading procedure, glycine-2-^{14}C and substances in biological equilibrium with this amino-acid were incorporated into the tissue proteins of the animals. Since the sarcosine moiety of creatine and creatinine is derived from glycine[4], the α-carbon and the N-methyl carbon atoms of the sarcosine moiety were also labelled with radioactive carbon. The carbon-14 activity of the N-methyl carbon arises from the contribution made by the α-carbon atom of glycine to the 'one-carbon fragment' pool. After irradiation, the tissue proteins undergo degradation, as evidenced by an increased excretion of carbon-14 activity in urinary hippuric acid[5]. This increase in activity of the urinary hippuric acid is a reflexion of the increased radioactivity of the free glycine pool caused by breakdown of the labelled proteins. In parallel with this increase in the carbon-14 activity of the excreted hippuric acid, the creatine–creatinine carbon-14 activity of the urine of the irradiated animals also increases, especially during the second collection period (Table 1). This alteration in the urinary creatine–creatinine carbon-14 activity may be due to either (1) an increased amount of glycine labelled with carbon-14 offered to the liver for creatine synthesis, with or without diminished utilization by the muscle, or (2) release of creatine labelled with carbon-14 consequent on changes in the muscle of the irradiated animals. Experiments are now in progress to test the validity of these hypotheses.

The other noteworthy finding in these experiments is an increased excretion of creatine. This creatinuria with its high isotope concentration in the creatine–creatinine fraction resembles that found in muscular dystrophy[6]. It has also been found that creatine and creatinine in the urine of the irradiated animals have approximately the same specific activity. This suggests that urinary creatine and creatinine are derived from muscle creatine or phosphocreatine[7].

A comparison of the specific activity of the urinary creatine–creatinine fraction (calculated as the average of the two labelled carbon atoms) with the specific

Table 1. Excretion and Carbon-14 Activity of Urinary Creatine–Creatinine and Hippuric Acid

Time interval after exposure (hr.)	Group	No. of animals (starved)	Creatine* (mgm.)	Creatinine* (mgm.)	Carbon-14 activity of combined creatinine–creatine fraction†	Carbon-14 activity of hippuric acid‡
0–24	Control	3	27·97 (22·68–33·81)	6·12 (3·58–9·9)	3,320 (2,100–4,080)	13,270 (10,450–15,350)
	Irradiated	6	28·69 (17·53–42·22)	7·37 (4·55–10·5)	5,560 (3,600–6,580)	18,670 (11,640–25,640)
24–48	Control	4	10·12 (8·7–14·36)	12·31 (10·5–15·68)	2,470 (1,610–4,140)	11,850 (8,750–14,280)
	Irradiated	6	21·54 (16·24–27·54)	8·86 (6·8–11·2)	5,000 (4,000–9,420)	18,000 (12,080–24,500)

* Total amount excreted during the time interval studied. The figures in parentheses represent the ranges, whereas the figures above these parentheses show the average values for the group.
† Counts per min./mgm. carbon (N-methyl + α-carbon atoms of sarcosine moiety).
‡ Counts per min./mgm. carbon (methylene carbon atom of glycine residue).

activity of the α-carbon atom of N-benzoyl glycine (hippuric acid) reveals that the ratio of hippuric acid to creatine–creatinine activity is significantly lower in the irradiated animals, suggesting that some of the creatine-creatinine fraction probably is newly synthesized.

Thus it was demonstrated that total-body exposure is accompanied by creatinuria and an increased isotope concentration in the urinary creatine–creatinine fraction. These findings are thought to be related to the myasthenia occurring as result of exposure to radiation.

The work was supported in part by the U.S. Atomic Energy Commission.

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Protective Action of Monospecific Anti-*Brucella* Sera in Mice

Monospecific anti-*Brucella* sera have been used in the past for serological identification of *Brucella* strains, on the basis of their property of agglutinating homologous organisms to a higher titre. It was considered of interest to determine whether these sera had immunological in addition to serological specificity—in other words, whether an absorbed anti-*Brucella abortus* serum would afford better protection against *Br. abortus* than against *Br. melitensis* and vice versa. A passive protection test in mice was employed. This test will be described in detail elsewhere (Sulitzeanu[1]) and therefore only a brief description of the methods will be given here.

Groups of five mice were inoculated intramuscularly with 0·1 ml. of the 1/5 serum dilution; 18 hr. later the mice were challenged intra-abdominally, together with untreated controls, with an appropriate number of living *Brucella*. The animals were killed seven days after challenge, the spleens of each group were removed and triturated together and the number of bacteria determined by culture. The logarithm of the ratio:

$$\frac{\text{Average number of bacteria per spleen of untreated mice}}{\text{Average number of bacteria per spleen of passively immunized mice}}$$

(called the 'protection index') gave a measure of the protection afforded. Statistical analysis showed a difference of 0·72 between two protection indexes to be significant at the 5 per cent level.

The sera used had been prepared by inoculation of rabbits with living *Br. abortus* 544 or *Br. melitensis* 16 *M*, and had been absorbed with the heterologous strains in order to obtain absorbed or monospecific sera. They were, in fact, sera used at Weybridge for routine typing purposes or issue for this purpose. Agglutinating titres before and after absorption are shown in Table 1.

Both absorbed and non-absorbed sera were inoculated into mice and the results are summarized in Table 2. It is clearly seen that the latter protected the animals against both strains, whereas the former

Table 1. Agglutinating Titres

Serum	Antigen *abortus*	Antigen *melitensis*
Anti-*abortus*, before absorption	5,120	5,120
Anti-*abortus*, after absorption	320	0
Anti-*melitensis*, before absorption	5,120	5,120
Anti-*melitensis*, after absorption	0	320

Table 2. Spleen Counts and Protection Indexes of Passively Immunized Mice
Challenge strains were *Br. abortus S*.19 and *Br. melitensis* 16 *M*

1/5 dilution of serum	Challenge dose	Challenge strain	Spleen count	Protection index
Non-absorbed anti-*abortus*	$2·8 \times 10^4$	*S*.19	100	4·06
Absorbed anti-*abortus*	"	"	33	4·54
Non-absorbed anti-*melitensis*	"	"	133	3·94
Absorbed anti-*melitensis*	"	"	483,000	0·38
No serum	"	"	1,150,000	
Non-absorbed anti-*melitensis*	$1·8 \times 10^4$	16 *M*	6,100	1·93
Absorbed anti-*melitensis*	"	"	7,500	1·84
Non-absorbed anti-*abortus*	"	"	2,250	2·86
Absorbed anti-*abortus*	"	"	36,100	1·16
No serum	"	"	521,000	

either protected only against the homologous challenge (*melitensis* serum) or protected better against homologous challenge (*abortus* serum).

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Microbiological Determination of Free Amino-Acids in the Body Fluid of the Silkworm Larva (*Bombyx mori*)

The kinds of free amino-acids present in the body fluid of the silkworm larva have been determined by paper chromatography[1], but little is known of the quantities present. The present work was carried out to determine the concentrations of individual free amino-acid by microbiological assay.

Material was obtained from the silkworm, *Si* 108 (*Kyu*), at the third and sixth days of the 5th instar (51 and 124 hr. from the commencement of the feeding period). The feeding period of the 5th instar was about 148 hr. The method of preparing the samples for microbiological assay was, in principle, that described by Elvehjem *et al.*[2] for the assay of rat blood plasma except for the precipitating agent. The precipitation of the proteins in the body fluid was carried out with trichloracetic acid instead of tungstic acid as a precipitating agent, because free amino-acids in the body fluid, especially some of the basic amino-acids, such as histidine and lysine, which are precipitated with the protein by using tungstic acid according to the procedure of Elvehjem *et al.*, are not precipitated by using trichloracetic acid[3]. 10 ml. of the body fluid which was collected in a tube kept in ice-water was added to a bottle containing 90 ml. of 3 per cent trichloracetic acid, and the bottle and contents allowed to stand at room temperature for 30 min. with intermittent shaking. The precipitates were removed by centrifugation, and the filtrates were heated in a boiling water-bath for a few minutes. The clear protein-free filtrates were adjusted to *p*H 6·8 with *N* sodium hydroxide, made up to 100 ml. with the distilled water and stored in a refrigerator under toluene until determinations were carried out. The microbiological assays on seventeen free amino-acids in the trichloracetic acid filtrates were carried out by the procedures described by Tamura *et al.*[4]. The 100- to 400-fold dilutions of the fresh body fluid were suitable for determining the majority of the amino-acids except histidine (400- to 2,000-fold dilutions).

The concentrations of free amino-acids in the body fluid are summarized in Table 1. Recovery of amino-acids added to the trichloracetic acid filtrates was 90–110 per cent in most cases. The individual free amino-acid concentrations in the body fluid obtained by using tungstic acid as the precipitating agent were, except for the basic amino-acids, in good agreement with those obtained by using trichloracetic acid. The concentrations of the individual free amino-acids in the body fluid on the sixth day of the 5th instar were found; histidine and lysine (more than 1,000 μgm./ml.), were very high; serine, aspartic acid, threonine, arginine, tyrosine, alanine, glutamic acid, valine, glycine, leucine and proline (460–100 μgm./ml.) came next; and phenylalanine, methionine, tryptophan and *iso*leucine (less than 100 μgm./ml.) were comparatively low. A somewhat similar value was also observed in body fluid of the third day of the 5th instar. Except for tyrosine[5], body fluid concentrations of the other individual free amino-acid shown here have apparently not been reported.

Table 1. Concentrations of Free Amino-Acids in the Body Fluid (Values in μgm. per ml.)

Amino-acids	Body fluid of the silkworm		Organism*	Human blood plasma (Bergeim *et al.*, ref. 7)	Rat blood plasma (Elvehjem *et al.*, ref. 6)
	Third day of 5th instar	Sixth day of 5th instar			
Alanine	305	176	*Cit*		
Arginine	356	210	*M*	16	32
Aspartic acid	60	240	*M*		
Glutamic acid	90	175	*S*		
Glycine	284	129	*M*		23
Histidine	2,199	2,805	*Cit*	14	10
*iso*Leucine	75	46	*M*	13	13
Leucine	153	116	*M*	19	27
Lysine	889	1,042	*M*	22	58
Methionine	97	78	*M*	5	10
Phenyl-alanine	73	96	*M*	10	14
Proline	103	104	*Cit*		43
Serine	201	463	*M*		
Threonine	314	237	*S*	17	44
Tryptophan	32	52	*M*	13	17
Tyrosine	279	202	*M*	10	22
Valine	255	138	*M*	27	27

* *Cit* = *Leuconostoc citrovorum*; *M* = *Leuconostoc mesenteroides*; *S* = *Streptococcus faecalis*.

In general, the concentrations of the individual free amino-acid in the body fluid of silkworm larvæ are strikingly different from those of the rat[6] and of human blood plasma[7] (Table 1); a particular feature is the much higher concentrations of basic amino-acids, such as histidine and lysine.

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Preparation of Metallic Isotopic Targets of the Alkali and Alkaline Earth Metals by Evaporation of their Compounds

Electromagnetically enriched isotopes of the elements lithium, potassium, rubidium, calcium, strontium and barium, after the necessary chemical processing, are only available in one of the standard gravimetric forms, whereas nuclear targets for reaction studies in high-voltage accelerators are

usually required as the element. It is scarcely feasible on the milligram scale to prepare the elements for evaporation; but the following simple method of making the targets is very successful. The oxide or carbonate of the isotopic element is pasted on to a boat composed of a strip of tantalum; this is directly heated in high vacuum, when oxide is reduced and the metal evaporates so that targets can be deposited using a cooled assembly. By control of the rate of heating and with suitable geometry, it is possible to achieve more than 50 per cent deposition on the backing, while the remainder of the evaporated material is recoverable. The target is then transferred to a tube which is stoppered while under vacuum and sealed off. When the target is required for use, it can be transferred to the accelerator without undue exposure to air. Alternatively, the target can be warmed in hydrogen or its isotopes to give the more stable hydrides. Deposits from a few micrograms to 1 mgm./cm.^{2} on a variety of backings are readily made.

The use of a tantalum boat was originally suggested by Russell *et al.*[1] for reduction of magnesium oxide to give isotopic magnesium targets.

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Scintillation Techniques for the Detection of Natural Radiocarbon

The development of liquid scintillators of high pulse-height efficiency has made possible a new technique for the determination of natural radiocarbon. If the carbon content of the sample can be incorporated into a liquid scintillator, a detector of high sensitivity and excellent geometry is inherently present, and the detector volume is reduced considerably in comparison with that of the screen-wall counter[1], thus lowering the background counting-rate. The synthesis of a suitable compound which can function directly as solvent or diluent is necessary for this method.

In this communication the synthesis and use of toluene as the solvent in a liquid scintillator is described. The synthesis of toluene containing seven sample carbon atoms per molecule appeared possible but impractical for routine work. Instead, the simpler expedient of incorporating sample carbon into only the alkyl group of the molecule appeared more feasible. This, of course, involved the dilution of the sample carbon to 1 atom in 7. Nevertheless, since this reduction is intermolecular, no quenching of the scintillations is involved such as may be encountered when different molecular species are used.

The problem of background counting-rate required careful attention. A massive lead and mercury shield was constructed, weighing approximately one ton, and with a wall thickness of 5 in. of lead and 1½ in. of mercury. The liquid scintillation cell (volume 20 c.c.) was mounted inside this shield on a selected DuMont *K*1190 photomultiplier of cathode diameter 1 in. The photomultiplier pulses passed to a high gain (× 4,000) non-overload amplifier via a cathode follower, and then to a wide-band differential discriminator and scaler. The differential discriminator made use of the proportional property of the scintillation counter by selecting only those pulses in the range of the energies corresponding to the β-spectrum of carbon-14. In this way a further reduction in the background counting-rate was achieved, as most γ- and cosmic-ray pulses were obviously rejected. The energy 'gate' selected was the range 40–100 keV., to include the carbon-14 β-distribution maximum, and at the same time eliminate all thermal noise from the photomultiplier tube. The carbon-14 β-ray efficiency obtained in this way was approximately 50 per cent. With a 20-c.c. 'old' toluene scintillator of petrochemical origin containing 4 gm. per litre of terphenyl and 1·0 gm. per litre of 2,5-diphenyloxazole, and freed from oxygen[2], the average of two 24-hr. counts gave a counting-rate of 3·34 ± 0·03 counts per min. This 'background' was regarded as entirely satisfactory for the testing of the new method, and so no attempt was made to incorporate cooling of the photomultiplier or anticoincidence shielding at this stage. The necessity for this shielding was almost entirely eliminated by the pulse-height sorting technique. The residual counting-rate of 3·34 counts/min. was due to (1) the rare cosmic-ray event which dissipates energy in the range of 40–100 keV. in the liquid; (2) γ-radiation which has been scattered in the shield until its energy is in the same range; (3) trace contamination of the materials of the photomultiplier and glass cell; (4) a long 'tail' on the photomultiplier 'noise' curve, possibly due in part to extremely rare cosmic- and γ-ray interactions with the materials of the photomultiplier.

The synthesis of a toluene sample containing modern carbon was carried out as follows. The sample was burned in a 'Vycor' combustion tube, and the carbon dioxide evolved was trapped in a solution of barium hydroxide. After washing and filtration, the barium carbonate was treated with perchloric acid to regenerate the carbon dioxide at a rate which was automatically controlled to correspond to its rate of absorption in a Grignard reaction to form benzoic acid. In other respects the procedure was similar to that recently reported for the preparation of labelled benzoic acid[3]. One gm.-mole of barium carbonate was employed, and a yield of 80 per cent based on carbon dioxide was obtained. The reduction of benzoic acid to benzyl alcohol was performed in a diethyl ether solution employing lithium aluminium hydride[4] as a reducing agent. A yield of 90 per cent was obtained. The benzyl alcohol was brominated with phosphorus and bromine in 75 per cent yield. The benzyl bromide was then converted to toluene with lithium aluminium hydride[4].

The 'modern' toluene obtained from this synthesis was then mixed with 'old' toluene to simulate samples of 16,800 years, 24,800 years and 35,000 years. The net sample counting-rates were determined to be 1·86 ± 0·04, 0·94 ± 0·04 and 0·30 ± 0·04 counts/min., respectively, based on the average of two 24-hr. counts in each case. Fig. 1 shows the results of these measurements, and indicates that the counting-rates are consistent and agree within statistical error. From the accepted half-life of carbon-14 and the known amounts of 'modern' carbon present, it was estimated that the carbon-14 counting efficiency was approximately 50 per cent.

It is evident from Fig. 1 that results of significance can be obtained for ages as great as 45,000 years with samples of the volume used here, and a counting

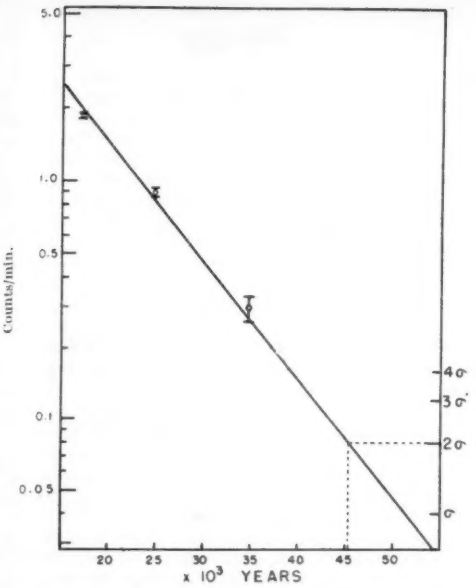

Fig. 1. Counting-rate plotted against age of sample for three 20-c.c. samples of 16,800, 24,800 and 35,000 years, respectively. The standard deviation σ of the background, for a 2-day count, is shown. It is evident that a 45,000-year sample will give an effect twice as large as the standard deviation of the background count

period of two to three days. Our results are shown in Table 1, together with comparable results (collected by Arnold[6]) for other methods.

The results of this investigation show that a liquid scintillation counter employing toluene from sample carbon as the solvent can be utilized for carbon-14 age determinations, with a single uncooled photomultiplier tube. The present synthesis, however, is somewhat involved for routine measurements of large numbers of samples. Further work in our laboratories on a simple synthesis of methanol from carbon dioxide shows considerable promise for development of a routine liquid scintillator technique for age determination[8], giving results comparable to those described above. Dr. J. R. Arnold[6], in an independent investigation, has proposed the use of liquid scintillator techniques, but has used a more complicated counting assembly which appears to give a somewhat higher background, even when due allowance is made for his larger cell volume.

Table 1

	Screen wall counter (ref. 1)	Gas counter (ref. 7) (acetylene)	33 per cent ethanol scintillation counter (ref. 6) (100-ml. cell)	Toluene scintillation counter (20-ml. cell)
Sample size (gm.)	8	3	14·2	2·2
Counting efficiency (per cent)	5·4	75	25	50
Net sample counting-rate (contemporary carbon (counts/min.)	6·7	34·5	54	16
Background counting-rate (counts/min.)	4·0	30·0	26	3·3

We are indebted to the Wenner-Gren Foundation for support of this work, and to the National Research Council of Canada for a grant-in-aid covering certain aspects of the investigation.

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Chemical Effects associated with 'Colour Centres' in Alkali Halides

Measurements of the chemical effects of colour centres have previously been made on additively coloured crystals[1,2] and on crystals irradiated with X-rays[3,4]. The usual method of measuring electron-excess centres has been to follow the change of *p*H which occurs on dissolving the crystals in water, due to the reaction $e + H_2O = \frac{1}{2}H_2 + OH^-$. This method is subject to errors due to the variable carbon dioxide content of solutions, and large effects have been reported with untreated material[2]. We have found that measurement of the gas evolved on dissolution of a treated crystal in carefully degassed water can be used successfully. Analysis of the gas in a Blacet–Leighton micro-apparatus always revealed 95–99 per cent hydrogen present. This method entails no uncertainties due to solution effects, and blank results were always obtained with untreated crystals. It can be applied most easily to concentrations of centres in the region of 10^{18} per cm.^{3} produced either by additive coloration or by ionizing radiation. Direct comparison of this chemical effect with the optical absorption of the *F*-band in additively coloured crystals is difficult at these concentrations, since very thin sections are required, and an appreciable concentration of other centres is usually present. However, work is in progress to correlate the optical and chemical effects of additively coloured crystals in carefully chosen specimens, so that further comparison may be made with irradiated crystals.

Electron defect centres have been measured[4] in irradiated sodium chloride crystals by using the *o*-tolidine reagent for measuring the 'free chlorine' content of solutions produced by dissolving the crystal in water. We have used this method and another based upon the oxidation of I^- to free iodine, measured spectrophotometrically as I_3^- in buffered solution[5]. Both methods gave similar results on the same sample of irradiated sodium chloride; but the iodometric

method was generally more reliable and proved easier to standardize.

Irradiations of sodium chloride crystals were carried out using a 5 μamp. target-current of 1·25 MV. electrons from a Van de Graaff generator. Relatively large concentrations of centres ($5 \times 10^{17} - 2 \times 10^{19}$/cm.^{3}) could be produced depending on irradiation conditions, and chemical effects were easily measured on specimens down to 10 mgm. in weight. The following results have been observed.

(1) Stability of centres. A sample of irradiated sodium chloride ground up to give a homogeneous mass gave the same analysis based on oxidizing power over a period of four weeks, being kept dry and in daylight throughout.

(2) Analyses by the methods discussed above showed that, on the same sample, electron excess and defect concentrations were equivalent. A previous explanation[6] of the stability of the *F*-centres produced by electrons was that chlorine, presumably equivalent to the number of *F*-centres, escaped from the crystal. Our results, plus the fact that these crystals can be bleached entirely by heating to 250° C., are in keeping with the mechanism proposed recently by Varley[7], but can also be explained on the model of a stable V_3 centre, proposed by Seitz[8].

(3) If a crystal was kept at room temperature by cooling with an air blast during irradiation, measurements showed that after 20 min. a reproducible saturation value of 7×10^{17} centres/cm.^{3} was reached. Fig. 1 shows the absorption spectrum of such a crystal, indicating the formation of well-defined *F*- and *M*-bands.

(4) Without the cooling effect of an air blast, the crystal became distinctly warm under irradiation at the same intensity, and a large increase in the number of centres became noticeable. After 2–3 hr. continuous irradiation, concentrations of centres up to 2×10^{19}/cm.^{3} were measured and the crystal became blue in colour. Fig. 2 shows the absorption spectrum of such a crystal, and it is seen that a new band is now present instead of the *F*- and *M*-bands found previously. The absorption spectrum of an additively coloured sodium chloride crystal is also included in the diagram. The main band appears to be the colloidal band described by Scott, Smith and Thompson[9], which has also been obtained in irradiated samples by Westervelt (see discussion, ref. 9), while the small band at 400 mμ may be analogous to the band of wave-length rather shorter than that

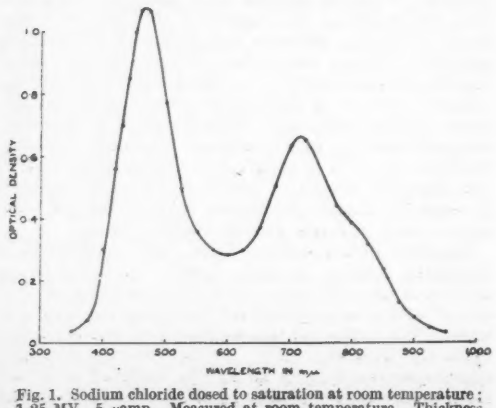

Fig. 1. Sodium chloride dosed to saturation at room temperature; 1·25 MV., 5 μamp. Measured at room temperature. Thickness 0·00626 cm.

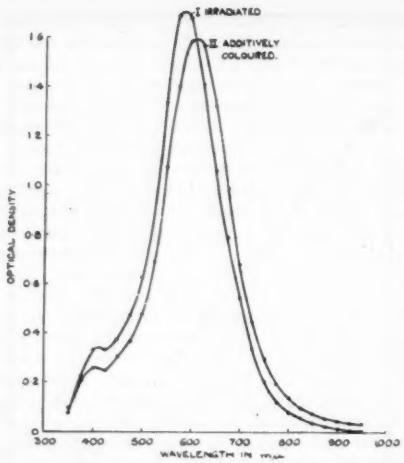

Fig. 2. I, sodium chloride irradiated hot, 1·25 MV., 5 μamp. for 2¼ hr. Thickness, 0·00246 cm. II, sodium chloride heated with sodium at 650° C. Thickness, 0·103 cm. Both measured at room temperature

of the *F*-band found in potassium iodide containing excess metal.

(5) It has been found that crystals of sodium chloride containing high concentrations of colour centres produced by electron irradiation are able to initiate the polymerization of acrylonitrile in aqueous solution. This effect is not observed with unirradiated crystals, nor with additively coloured specimens; it can only be explained on the assumption that free atoms are produced by irradiation within the crystal, which become available for chemical reaction on dissolution in water.

Earlier experiments with electron irradiated pellets of compacted cæsium chloride powder gave similar results for chemical determinations to those described above. Again the highest concentration measured was $\sim 2 \times 10^{19}$ centres/cm.^{3}. Mr. T. H. Bates, of this laboratory, has also carried out measurements on several alkali halides (sodium chloride, potassium chloride, cæsium chloride, potassium bromide, potassium iodide) irradiated in a kilocurie cobalt-60 γ-source for periods up to 20 hr. Chemical changes due to the production of free halogen atoms were observed as before, although the scale of effects was reduced.

This work will be reported in full elsewhere. Our thanks are due to Mr. J. D. Milne and Mr. B. Morris, who kindly operated the Van de Graaff machine during the irradiations.

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Structure of Native and Mercerized Celluloses

THE crystal unit-cells proposed by K. Meyer and H. Mark[1] and K. Meyer and L. Mish[2] for cellulose lattices I and II, and for which there seemed to be general agreement, have been discussed recently by M. K. Sen and S. C. Roy[3]. These authors have given a new interpretation to X-ray diagrams obtained from these fibres, based on the existence of a strong diffraction intensity corresponding to a reticular distance of the order of 14 A. This interference result had hitherto not been observed for these substances. This new interpretation has been considered with certain reservations by G. O. Warwicker and H. J. Vellard[4], who have pointed out the causes of errors already remarked upon by other investigators. H. J. Woods[5], on the other hand, has observed a small-angle spot for jute very near that observed by Sen and Roy.

It seemed worth while to us to repeat this work on a group of textile fibres (ramie, viscose, linen, 'Fortisan', etc.) using experimental techniques beyond criticism.

X-ray diagrams were obtained with a diffraction camera which was designed especially for fibre studies[6]. In brief, the film is placed in a vacuum, the X-ray beam coming from a copper anticathode is monochromatized by reflexion from a curved quartz crystal, and the focalization is exact for all angles within the equatorial plane (Guinier[7]).

The diffraction diagrams may be obtained up to approximately 20 A. Furthermore, the mounting of a double monochromator[8] in a vacuum, making it possible to obtain diagrams at very small angles, permits us to record the diffusion from 200 A. up to reticular distances corresponding to intense equatorial interferences of the cellulose fibres (101) and (10$\bar{1}$), or (101) for mercerized cellulose. Diagrams were obtained using samples that were dried as much as possible and then afterwards humidified.

In every case no reflexion corresponding to a reticular distance of 14 A. could be observed. Only jute (an imperfectly delignified sample) gave an equatorial spot corresponding to 14 A.; but its intensity was very weak (4 or 5 per cent of the intensity of (101) at the very most).

The perfect agreement of the results obtained by means of the use of two complementary methods indicated that, for the group of cellulose fibres, the interference observed by Sen and Roy could not be repeated. In the case of jute the purity of the cellulose must be challenged.

As a result it appears that the customary interpretation of fibre photographs will not have to be modified. On the other hand, we have succeeded in demonstrating that, under certain faulty experimental conditions, it is possible to observe aberrant reflexions. Thus by irradiating the fibres with a beam from a tube having a chromium anode, we have observed the spots noted by Sen and Roy. Moreover, monochromatization of the beam caused these spots to disappear. This proves that in the case of substances which are as badly crystallized as the textile samples, one must give special attention to experimental techniques, and in particular to the composition of the X-ray beam used.

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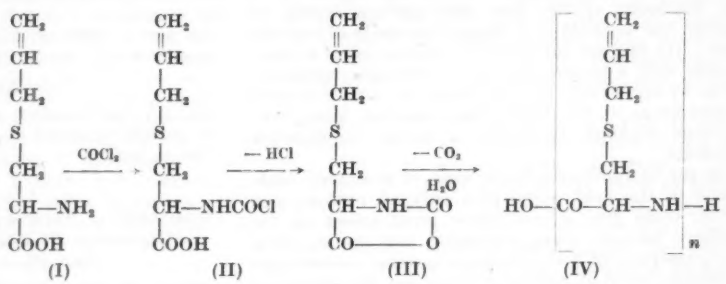
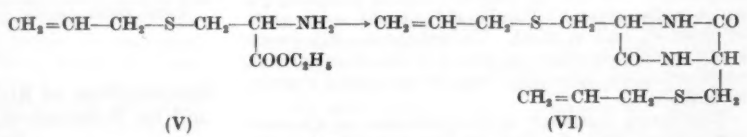
Synthesis of Poly-S-Allylcysteine (Poly-Deoxo-Alliin)

WE wish to report briefly on the synthesis of poly-S-allylcysteine (IV) (poly-deoxo-alliin), from 1-S-allylcysteine (I), by the route indicated in the scheme:





1-S-Allylcysteine, prepared according to Stoll and Seebeck[1], yielded the appropriate N-carboxyanhydride (III), via the intermediary chloride (II), on passing phosgene for about two hours at 60° through a suspension in dry dioxane. The solution was evaporated *in vacuo* at 40° and the residue kept overnight in a vacuum desiccator over phosphorus pentoxide. The remaining crystalline mass (melting point about 50°) was recrystallized from dry ethylacetate – petroleum ether, and the pure N-carboxyanhydride (III) melted at 55° with resolidification at about 115°.

Polymerization of (III) was carried out either in solution or in bulk in high vacuum. Pyridine, dioxane (with the addition of a trace of water when working in the cold or dry if heating to about 100°), glacial acetic acid or ethanol was used as solvent. On heating in bulk in a high vacuum, actual polymerization took place only on raising the temperature considerably above the melting point of (III)—at about 150°; at temperatures of about 100–105°,

unchanged Leuchs anhydride was recovered. In its solutions, the anhydride is much less stable and polymerization takes place readily, especially on heating.

The purified polymers obtained give a biuret reaction on prolonged standing; they are practically insoluble in the usual solvents, including dilute acids and alkali, but partly soluble in anhydric formic acid, glacial acetic acid, dimethyl formamide and dichloroacetic acid.

In the course of the present experiments the diketopiperazine derivative (VI) was also obtained from the ethyl ester (V).

The experiments described here are part of an investigation on the polymerization of amino-acids and their derivatives, containing unsaturated bonds, the results of which will be published at a later date.

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Proof of the Heisenberg Relations

Since Heisenberg's uncertainty relations play an essential part in quantum mechanics, especially in the discussion of the dual wave-particle aspect of matter, the derivation of these relations is of importance. We became interested in this problem in connexion with a lecture course on quantum mechanics given by one of us. In this course we wished to give a derivation of the Heisenberg relations which was rigorous without, however, involving commutator relations.

In the literature we found that, of the many textbooks in the field, some give only an outline of a proof, some give a qualitative proof based on the analogy between wave mechanics and optics, using the properties of wave trains, some use commutator relations, while Moyal[1] and Weyl use the Schwartz inequality. The well-known proof due to Heisenberg[2], which is also given by Pauli and Rojanski, is the kind of proof we had in mind. Unfortunately, this proof is not completely rigorous, and it is the object of this communication to modify Heisenberg's proof slightly to make it so.

Restricting ourselves to the discussion of the one-dimensional case, let $\psi(x)$ be the normalized wave function of the electron with its Fourier expansion,

$$\psi(x) = \int A(\sigma) \exp(2\pi i\sigma x) d\sigma \qquad (1)$$

where x is the position of the electron, and σ the wave number. We have from equation (1),

$$A(\sigma) = \int \psi \exp(-2\pi i\sigma x) dx \qquad (2)$$

We introduce now the mean position, x_0, the mean wave number, σ_0, the uncertainty in position, Δx, and the uncertainty in wave number, $\Delta\sigma$, by the equations,

$$x_0 = \int x|\psi|^2\, dx, \quad \sigma_0 = \int \sigma|A|^2\, d\sigma,$$

$$\Delta x^2 = \int (x-x_0)^2|\psi|^2\, dx, \quad \Delta\sigma^2 = \int (\sigma-\sigma_0)^2|A|^2\, d\sigma \qquad (3)$$

We choose the origin of the x and σ scales in such a way that $x_0 = \sigma_0 = 0$, so that the last two equations (3) become

$$\Delta x^2 = \int x^2|\psi|^2\, dx,$$

$$\Delta\sigma^2 = \int \sigma^2|A|^2\, d\sigma = (4\pi)^{-2}\int \left(\frac{\partial\psi}{\partial x}\right)^2 dx \qquad (4)$$

the last equation following in the usual way.

It is clear that the following inequality will always hold, irrespective of the choice of constant a:

$$|ax\psi + (\partial\psi/\partial x)|^2 \geqslant 0 \qquad (5)$$

From expression (5) it follows by the usual analysis that

$$a^2\Delta x^2 + 4\pi^2\Delta\sigma^2 \geqslant a \qquad (6)$$

At this point, Heisenberg puts $a = (2\Delta x^2)^{-1}$ and thus obtains the Heisenberg relations. There is, however, no obvious reason for this choice of a, and by choosing a different value one could derive relations between Δx and $\Delta\sigma$ which would be completely different from the Heisenberg relations.

The proof of the Heisenberg relations, however, can be completed in the following way. From inequality (6) we see that the smaller Δx^2 is, the larger, in general, will be $\Delta\sigma^2$ and that the smallest combination occurs when the equality sign holds, that is, when ψ satisfies the equation,

$$ax\psi + (\partial\psi\partial/x) = 0 \qquad (7)$$

The wave function satisfying equation (7) is of the Gaussian form and a is *now* related to Δx^2 by the equation $a = (2\Delta x^2)^{-1}$; but this is not necessarily true for a different form of ψ. Substituting this value of a into equation (6), we get,

$$\Delta\sigma.\Delta x = 1/4\pi \qquad (8)$$

and since the situation is less favourable when ψ does not satisfy equation (7), we get in general $\Delta\sigma.\Delta x \geqslant 1/4\pi$ as before.

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Germination of Rice Embryo under Water and its Relation of Growth to Endosperm Fractions

It is a well-known fact that rice seeds are capable of germination under water and the coleoptile of the rice embryo grows more rapidly and more extensively under water than in air. Yamada[1] suggested that the superior growth of the rice coleoptile under water is due to the decreased capacity of the coleoptile tissue for destroying auxin under water as compared to the extensive capacity of the tissue for destroying auxin in air. Sircar and Das[2] have shown that the auxin of the rice endosperm gradually decreases with the growth of the coleoptile and root; such gradual consumption of auxin is stopped abruptly when the embryo is detached from the endosperm.

It has been observed that some factor present in the endosperm has a distinct inhibitory effect on the growth of the rice embryo kept under water or grown in air. Experiments were carried out with husked rice grain (variety Bhasamanik) from which different fractions of endosperm were removed, kept under water and on agar slopes in air in darkness at 25° C.

Table 1. GROWTH OF RICE EMBRYO (VAR. BHASAMANIK) KEPT UNDER WATER AND IN AIR, 144 HR. OLD AT 25° C. IN DARKNESS

	Under water			In air		
	Mesocotyl (mm.)	Coleoptile (mm.)	Root (mm.)	Mesocotyl (mm.)	Coleoptile (mm.)	Root (mm.)
Embryo with full endosperm	nil	34·5	0·1	45·8	7·0	58·4
Embryo with ¾ endosperm	nil	35·0	0·4	43·8	7·2	70·2
Embryo with ½ endosperm	nil	51·3	1·5	41·3	7·4	61·3
Embryo with ¼ endosperm	nil	18·2	nil	20·0	6·0	37·1

It is evident from Table 1 that the coleoptile of submerged embryos and the root growth of air-grown embryos have been accelerated by the elimination of a portion of endosperm. When more than half the endosperm was removed, no such effect of acceleration was observed. Under water, the growth of root and second leaf is almost completely suppressed, the hollow coleoptile elongates by its tapering end and it never breaks open. In complete darkness the germination of rice seed under water is significantly inferior to that in light (even so little as one or two minutes exposure in every twenty-four hours). In darkness, suppression of the mesocotyl growth of the submerged embryo is another interesting contrast to the much elongated mesocotyl of air-grown embryos.

Germination of oat seedlings under constant illumination results in the suppression of growth of the mesocotyl. The reasons for this are not well understood. Van Overbeek[3] has stated: "The growth of the mesocotyl is quite dependent on the amount of auxin left over by the coleoptile. If this amount is large, a large growth will result; if the amount is small, then little mesocotyl growth will result". Galston and Baker[4] have shown that the suppression of growth of pea epicotyl is due to the deactivation of auxin by light in the presence of riboflavin. Yamada[1] has suggested that, under water, deactivation of auxin is less and hence the length of the coleoptile is greater; but there is no reason for the suppression of the rice mesocotyl, which should not occur if the deactivation of auxin is decreased. Further, growth of the coleoptile is found to be still higher when half the endosperm is eliminated and the coleoptile presumably supplied with less auxin either in the active state or in the form of a precursor. The reasons for the acceleration of growth by elimination of endosperm fractions are not clear.

It may be presumed that the amount of auxin or some unknown factor present in the rice endosperm is more than optimal for the early growth of the embryo; hence elimination of a fraction of endosperm makes the level of auxin or the unknown factor optimal for embryo growth, until such elimination reaches a limiting value. Compared with the control (embryo with full endosperm and without added auxin), it has also been found that, on addition of indolylacetic acid to the growing embryo with three-quarters endosperm, acceleration effects on root growth were not observed. Coleoptile tip also plays an important part in the production of auxin in the embryo, for Das[5] has shown that excised embryo of rye can produce its own auxin without the intervention of endosperm. It appears that the whole problem is complex and more work is required on the nature of transport of auxin from the endosperm of the embryo, the quantity produced by the coleoptile itself and lastly how the growth of different parts of the embryo are regulated under different conditions.

Further work is in progress and the results will be published shortly. We thank Dr. I. Banerjee, head of the Department of Botany, University of Calcutta, for facilities for this investigation.

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A Mosaic Disease of Leguminous Plants caused by a Strain of Tobacco Mosaic Virus

WHILE collecting viruses for use in investigating the inhibition of virus infectivity by extracts of *Theobroma cacao* L., one was found causing a systemic mosaic disease in cow-pea (*Vigna unguiculata* (L.) Walp.) and Bengal bean (*Mucuna aterrima* Holland). The behaviour and properties of the virus suggest that it is related to tobacco mosaic virus, although we have been unable to find any previous report of strains of this virus infecting leguminous plants systemically.

The leaves of infected cow-pea and Bengal bean show light and dark green mottling which varies in severity, and they are somewhat distorted. The disease is now prevalent in these two crops at Moor Plantation; but there is no reason to think that it is a recent introduction. Mosaic symptoms have been recorded commonly in cow-pea and Bengal bean since 1941, not only at Moor Plantation but also at several farms of the Department of Agriculture in the Western and Northern Regions of Nigeria.

The virus is easily transmitted by inoculating sap from diseased plants to cow-pea, Bengal bean, *Nicotiana tabacum* L., *Nicotiana glutinosa* L. and several varieties of French bean (*Phaseolus vulgaris* L.). The only symptoms in *N. glutinosa* are necrotic local lesions; in *N. tabacum* var. Virginia Hybrid, chlorotic primary lesions are followed by a systemic mosaic and distortion of the leaves. The virus from cow-pea causes a systemic mosaic on the fourteen varieties of French bean tested, in contrast to our stock strain of tobacco mosaic virus, which produces discrete local lesions on some varieties but no systemic symptoms in any.

Colourless preparations of the cow-pea mosaic virus were readily made from the sap of infected tobacco plants by repeated precipitation with ammonium sulphate, and solutions of the purified virus showed the phenomenon of anisotropy of flow strongly. Mr. F. C. Bawden, of Rothamsted Experimental Station, found that a purified preparation was precipitated specifically with an antiserum prepared against his stock strain of tobacco mosaic virus, and with the electron microscope Mr. H. L. Nixon found that it contained rod-shaped particles of varying lengths, indistinguishable from the particles of strains of tobacco mosaic virus he had previously examined. In the Rothamsted glasshouses in December, the

virus produced a systemic mosaic disease in *P. vulgaris* var. Prince.

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Normal Mouth and Intestinal Flora of the Ferret (*Mustela furo* L.)

Although the ferret is widely used as an experimental animal, particularly in the study of virus diseases, very little work has been done on the commensal bacteria of the animal itself. Some work on its pathological conditions has been published by Hughes[1], Momberg-Jorgensen[2], Symmers and Thomson[3], Symmers, Thomson and Iland[4], and Skulski and Symmers[5]; but none has been found concerning the bacterial flora which can commonly be isolated from the mouth and intestine of the healthy ferret. The present investigation was made to study this flora, in a colony of tuberculosis-free ferrets, maintained in first-class conditions, which has its own unit of breeding gills, and is augmented at intervals by fresh stock purchased from breeders in the surrounding area.

One hundred and eighteen ferrets were examined as soon as possible after joining the colony. Swabs were taken from the mouth and throat and from the rectum. These were cultured on horse-blood agar and McConkey's medium, and incubated aerobically and anaerobically at 37° C. for a minimum period of 72 hr. The animals were fasted for 16 hr. before being swabbed orally.

As it was not practicable to kill healthy ferrets, the internal organs were not examined. Therefore, no results are available for comparison with those of Schweinburg and Sylvester[6] in other laboratory animals.

The flora isolated from the ferrets was usually mixed, comprising at least two bacterial species; but these were not always the same from the mouth and the rectum. The commonest organism was *Bacterium coli*, which was isolated from 108 of the 118 ferrets (91·5 per cent). Most strains were lactose fermenters but nine were atypical varieties, The other bacteria isolated were strains of *Proteus vulgaris*, *Staphylococcus albus*, alpha- and beta-hæmolytic streptococci, *Micrococcus catarrhalis*, diphtheroids chiefly *Corynebacterium xerosis* types, *Pseudomonas pyocyanea* and Gram-positive spore-bearing bacilli. These bacteria were not further identified nor was any selected for individual study.

The observations are grouped in Table 1 to show the site of origin of each bacterial species and the number of times it was isolated, and in Table 2 to show the number of ferrets from which one or more bacterial species were isolated.

From these observations it would appear that the flora of the alimentary tract of the ferret is similar to that of other animals. The relatively high proportion of strains of *Proteus* which was isolated from 74 of 118 ferrets (62·7 per cent) might be significant, although a comparable proportion was reported by Goret *et al.*[7], who found it in the fæces of 68·1 per cent of dogs which showed no signs of intestinal infection. The absence of anaerobes such as the *Clostridia* commonly present in the fæces of many animals is also noteworthy.

Table 1

Bacterium	Number of ferrets from which it was isolated			
	Oral swab	Rectal swab	Both	Total
Bact. coli, typical	19	27	53	99
Bact. coli, atypical	5	3	0	8
P. vulgaris	12	48	14	74
Staph. albus	43	7	5	55
Streptococcus				
alpha-hæmolytic	25	6	0	31
beta-hæmolytic	3	7	0	10
M. catarrhalis	21	0	0	21
Diphtheroids	14	0	0	14
Ps. pyocyanea	17	1	1	19
Spore-bearing bacilli	3	3	0	6

Table 2

Number of bacterial species isolated per ferret	1	2	3	4	5	6	7	8
Number of ferrets	9	35	36	29	8	1	0	0

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Effect of Chloretone on Tunicate Embryos

It has been known for many years that amphibian embryos, allowed to develop under narcosis before muscular movements start, show the normal reflex and muscular activity when removed from the anæsthetic[1]. Amphibian tadpoles can be narcotized only for short periods, as they need to feed.

The tadpoles of *Ciona intestinalis* do not suffer this disadvantage, as they do not feed before metamorphosis. I have found that embryos of *Ciona* placed in 0·1 per cent chloretone in sea water five hours before hatching do not show the muscular twitching seen in controls and show no hatching movements at all. In the majority of cases the egg membranes eventually disintegrate, but in some they remain intact until metamorphosis is well advanced. The narcotized tadpoles metamorphose at approximately the same time as free-swimming controls. A period of free swimming has previously been thought necessary for metamorphosis[2] in the non-viviparous ascidians; but the observation reported here does not support this.

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FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Tuesday, June 14

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

Wednesday, June 15

UNIVERSITY OF LONDON (at the London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2), at 5 p.m.—Mr. John Madge: "Social Policy in Relation to Housing". (Sixth of seven University Extension Lectures of "The Development and Pattern of the Social Services".)

ROYAL METEOROLOGICAL SOCIETY (joint meeting with the CHALLENGER SOCIETY, at 49 Cromwell Road, London, S.W.7), at 5.15 p.m.—Discussion on "Wind and Waves".*

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Annual General Meeting, followed by Lieut.-Gen. Sir William MacArthur: "An Account of Some of Sir David Bruce's Researches, based on his Own Manuscript Notes".

Thursday, June 16

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. C. H. Best, F.R.S.: "Dietary Factors in the Protection of the Liver, Kidneys, Heart and other Organs in Experimental Animals—the Lipotropic Agents" (Croonian Lecture).

INSTITUTION OF MINING AND METALLURGY (in the Apartments of the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. R. Haslam, Mr. R. D. J. Owens and Mr. J. Hancock: "Application of Plastic Igniter Cord to Blasting Operations in Metalliferous Mines"; Dr. G. A. Schnellmann: "Concealed Lead-Zinc Fields in England".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. K. W. Gruenberg: "Recent Work on the Commutator Structure of Infinite Groups".

Friday, June 17

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Discussion on "The Requirement for Radar Charts at Sea".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. Sir Harold Spencer Jones, F.R.S.: "The International Geophysical Year".

Saturday, June 18

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, University of Oxford), at 11 a.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER or LECTURER IN ZOOLOGY—The Registrar, The University, Hull (June 15).

LECTURER (Grade II) IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Birmingham 15 (June 15).

LECTURER (with a degree in dairying and a strong background of bacteriology) IN DAIRYING AND HEAD OF THE DAIRY SCHOOL—The Principal, Seale-Hayne Agricultural College, Newton Abbot, Devon (June 15).

ASSISTANT, Grade B (with a good honours degree and preferably industrial or teaching experience) to teach organic or inorganic chemistry to degree level and general chemistry to intermediate level—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham, Essex (June 18).

ASSISTANT EXPERIMENTAL OFFICER IN THE DEPARTMENT OF PHYSIOLOGY AND PLANT CULTURE to assist in experiments concerned with the control of plant environment—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts (June 18).

LECTURER IN PUBLIC HEALTH AND SOCIAL MEDICINE—The Secretary, The University, Aberdeen (June 18).

LECTURERS (2) (with teaching and industrial experience and a special knowledge of one of the following: electrical machinery, vibration analysis and engineering acoustics, communications (other than radio)) IN ELECTRICAL ENGINEERING—The Secretary of University Court, The University, Glasgow (June 18).

RESEARCH DEMONSTRATOR IN PURE MATHEMATICS—The Registrar, The University, Sheffield (June 18).

SCIENTIFIC OFFICER, Grade 3 (with a university degree of high standard in aeronautical engineering or equivalent qualifications, and several years experience in wind tunnel investigations related to the aerodynamic development of aircraft missiles), IN THE AERONAUTICAL RESEARCH LABORATORIES, Department of Supply, Fishermen's Bend, Victoria, Australia, to work on the aerodynamic development and research relating to new types of aircraft and missiles, and on general problems of low speed aerodynamics—The Senior Representative (AP.28), Department of Supply, Australia House, Strand, London, W.C.2 (June 18).

SENIOR LECTURER (with a degree in pharmacy and teaching and research experience) IN PHARMACEUTICS—The Registrar, College of Technology, Suffolk Street, Birmingham (June 18).

SENIOR RESEARCH FELLOW or RESEARCH FELLOW IN THE DEPARTMENT OF PURE MATHEMATICS—The Secretary, The University, Birmingham 15 (June 18).

ASSISTANT LECTURER (Grade III) IN PHYSIOLOGY (Veterinary)—The Registrar, The University, Bristol 8 (June 20).

ASSISTANT LECTURER IN STATISTICS—The Registrar, The University, Leeds (June 20).

LECTURER or ASSISTANT (Grade B) (with special interests in inorganic chemistry) IN THE DEPARTMENT OF CHEMISTRY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (June 20).

TUTORIAL STUDENTS (graduates or about to graduate) IN BOTANY, MATHEMATICS, MECHANICAL ENGINEERING and PHYSICS—The Registrar, King's College, Strand, London, W.C.2 (June 20).

LECTURER IN BACTERIOLOGY—The Secretary, The University, Aberdeen (June 23).

LECTURER or ASSISTANT LECTURER (with special qualifications in inorganic or physical chemistry) IN THE DEPARTMENT OF INORGANIC AND PHYSICAL CHEMISTRY—The Registrar, The University, Liverpool (June 25).

SENIOR LECTURER IN PATHOLOGY—The Registrar, The University, Sheffield (June 25).

SENIOR LECTURER IN RADIOCHEMISTRY IN THE DEPARTMENT OF INORGANIC AND PHYSICAL CHEMISTRY—The Registrar, The University, Liverpool (June 25).

SENIOR LECTURER IN THE DEPARTMENT OF PATHOLOGY—The Secretary, The University, Edinburgh (June 25).

PROFESSOR (scholar of high repute and with extensive research work in both experimental and theoretical nuclear physics and experience in guiding research in nuclear physics) OF THE INSTITUTE FOR NUCLEAR PHYSICS—The Director, Institute for Nuclear Physics, 92 Upper Circular Road, Calcutta 9 (June 27).

LECTURER IN CIVIL ENGINEERING—The Registrar, The University, Sheffield (June 28).

SHELL STUDENTS IN CHEMICAL ENGINEERING—The Registrar, King's College, Strand, London, W.C.2 (June 28).

LECTURER IN MATHEMATICS at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (June 30).

LECTURER (with experience in the field of inter-connected power systems) IN ELECTRICAL ENGINEERING at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 30).

MAY AND BAKER RESEARCH FELLOW (graduate in science, with specialization in biochemistry and plant physiology), to undertake research work on plant growth-regulating substances, under the direction of Prof. R. L. Wain—The Registrar, Wye College (University of London), Wye, Ashford, Kent (June 30).

RESEARCH ASSISTANT IN THE DEPARTMENT OF GEOLOGY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (June 30).

SENIOR LECTURER IN APPLIED MATHEMATICS at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (June 30).

SENIOR RESEARCH FELLOW (graduate in science or chemical engineering and experience in coal research) IN COAL RESEARCH, at the University of Sydney, Australia, to plan and undertake research on occurrence, nature, or utilization of coal—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Sydney, June 30).

SENIOR TECHNICIAN IN THE DEPARTMENT OF PHYSICS, TECHNICIAN IN THE DEPARTMENT OF CHEMISTRY, and a TECHNICIAN IN THE DEPARTMENT OF AGRICULTURE, at the University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (June 30).

STUDENTS (honours graduates in physics or in a biological subject) IN BIOPHYSICS and in MEDICAL PHYSICS, in the Physics Department—The Secretary, Institute of Cancer Research, Royal Cancer Hospital, Fulham Road, London, S.W.3 (June 30).

DEMONSTRATOR (preferably wanting research experience in cytology) IN THE DEPARTMENT OF BOTANY—The Registrar, The University, Leeds 2 (July 1).

CHEMIST or PHYSICIST, Senior Technical Officer or Technical Officer grade (with a university degree in science with chemistry or physics as a major subject, or a Technical College diploma in chemistry, physics or chemical engineering, or equivalent qualifications), IN THE DIVISION OF INDUSTRIAL CHEMISTRY, Section of Organic Chemistry, Commonwealth Scientific and Industrial Research Organization, Fishermen's Bend, Melbourne, Australia, to assist in the development and application of distillation and other techniques to the chemical examination of fats and waxes—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (July 2).

LECTURER/SENIOR LECTURER IN BOTANY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, July 2).

LECTURERS (2) IN BIOPHYSICS—The Secretary, The University, Edinburgh (July 2).

SENIOR LECTURER IN STATISTICS at Canberra University College, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, July 4).

LECTURER or ASSISTANT LECTURER (with medical qualifications) IN PHYSIOLOGY—The Registrar, Trinity College, Dublin (July 9).

SENIOR LECTURER or LECTURER IN PHYSICS at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Dunedin, July 15).

GEOLOGIST (with a degree or equivalent in geology or passed the final examination leading to a degree, and a satisfactory knowledge of (*a*) petrology and mineralogy or (*b*) the geology and mapping of glacial and other unconsolidated deposits or (*c*) stratigraphy and palaeontology) IN THE IRISH GEOLOGICAL SURVEY—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (July 29).

LECTURER IN ANTHROPOLOGY at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London W.C.1 (New Zealand, July 31).

LECTURER IN PHILOSOPHY at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 1).

ASSISTANT BIOCHEMIST (B.Sc., with a first- or second-class honours degree in chemistry or biochemistry, or the A.R.I.C.)—The Administrative Officer, Group Pathology Laboratory, Withington Hospital, Manchester 20.

ASSISTANT GOVERNMENT CHEMIST (Fellow or Associate of the R.I.C. (Branch E.) or with an honours degree in chemistry of a British university or equivalent qualifications) in Nigeria, for general analytical duties including bacteriological and chemical analysis of water, and forensic work—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.97/14/01.

BRITISH NYLON SPINNERS LIMITED RESEARCH FELLOW for work on the structure of wool and nylon staple fibre fabrics—The Principal, Technical College, Bradford 7.

ELECTRICAL ENGINEERS and PHYSICISTS (preferably with H.N.S. or degree in physics or electrical engineering, or at least H.S.C. (science) or equivalent) at the Ministry of Supply Radar Research Establishment, Malvern, Worcs, for research and development work, mainly on radar and electronic equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.231/5A.

LECTURER (Grade II) IN ZOOLOGY—The Registrar, The University, Edgbaston, Birmingham.

LECTURER IN INDUSTRIAL METALLURGY—The Registrar, The University, Birmingham 15.

LECTURER (with a good honours degree in electrical engineering and experience in servo-mechanisms) IN ELECTRONICS—The Secretary, Royal Technical College, Glasgow.

LECTURER (with a university degree in agriculture, and preferably with a knowledge of tropical agriculture and some teaching experience) IN AGRICULTURE, at the College of Agriculture, Mauritius—The Director of Recruitment, Colonial Office, 2 Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.63/52/06.

PROFESSORS OF STRUCTURAL ENGINEERING; HYDRAULIC ENGINEERING; MECHANICAL ENGINEERING; and MECHANICAL ENGINEERING with special qualifications in applied thermodynamics and machine design; Electronics and Telecommunications Engineering; Mathematics; Physical Chemistry; Chemical Engineering and Applied Biology, at the Israel Institute of Technology, Haifa, Israel—The Secretary, The Technion Society of Great Britain, 83 Wimpole Street, London, W.1.

RESEARCH ASSISTANT (Ph.D. standard), for work on reaction kinetics at gas-solid interfaces—Dr. F. C. Tompkins, F.R.S., Imperial College, London, S.W.7.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Publications of the Thoresby Society. Kirkstall Abbey Excavation—Fifth Report, 1954. Pp. 67–82+plates 9 and 10. (Leeds: Thoresby Society, 1955.) 1*s*. [124

Lundy Field Society. Eighth Annual Report, 1954. Pp. 45+2 plates. (Exeter: L. A. Harvey, University College, 1955. (Secretary, Lundy Field Society).) 2*s*. 6*d*. [124

Aluminium Development Association. Information Bulletin No. 7: Machining Aluminium. Pp. 56. (London: Aluminium Development Association, 1954.) 2*s*. [124

General Register Office. The Registrar General's Quarterly Return for England and Wales. Births, Deaths and Marriages; Infectious Diseases; Weather; Population Estimates. Quarter ended 31st December, 1954. (No. 424, 4th Qtr. 1954.) Pp. 35. (London: H.M. Stationery Office, 1955.) 2*s*. net. [124

Ramblers' Association. Annual Report of the Ramblers' Association, 1954. Pp. 34. (London: Ramblers' Association, 1955.) [124

Science Masters' Association. Report of Committee and Balance Sheets, 1954. Pp. 34. (London: Science Masters' Association, 1955.) [194

Royal Technical College, Glasgow. Annual Report of the One Hundred and Fifty-Eighth Session, 1953–1954. Pp. 40. (Glasgow: Royal Technical College, 1954.) [194

Rowett Research Institute. Collected Papers—Summary and Subject Reviews. Vol. 11. Pp. 44. (Bucksburn, Aberdeenshire: Rowett Research Institute, 1955.) 5*s*. [194

Veterinary Reviews and Annotations. Vol. 1, Part 1 (April 1955). Prepared by the Commonwealth Bureau of Animal Health, Weybridge, Surrey, England. Pp. 54. (Published half-yearly, two issues per volume. Annual subscription, 25*s*.) (Farnham Royal: Commonwealth Agricultural Bureaux, 1955.) [194

Scottish Education Department. Supply of Teachers of Mathematics and Science in Scotland: Report of the Committee appointed by the Secretary of State for Scotland. Pp. 40 (Cmd. 9419). (Edinburgh: H.M. Stationery Office, 1955.) 1*s*. 6*d*. net. [194

Ministry of Education: Science Museum. Handbook of the Collection Illustrating Temperature Measurement and Control. By J. A. Chaldecott. Part 2: Catalogue of Exhibits with Descriptive Notes. Pp. vi+57+6 plates. (London: H.M. Stationery Office, 1955.) 3*s*. 6*d*. net. [194

Department of Scientific and Industrial Research. Report of the Water Pollution Research Board, with the Report of the Director of Water Pollution Research, for the year 1954. Pp. vi+65+4 plates. (London: H.M. Stationery Office, 1955.) 3*s*. 6*d*. net. [194

Other Countries

Veröffentlichungen des Fraunhofer Instituts Freiburg I.B. Sonnen-Zirkular für die Monate Oktober, November, Dezember, 1954. Pp. 44. (Freiburg I.Br.: Fraunhofer Institut, 1955.) [124

Canada: Department of Mines and Technical Surveys. Publications of the Dominion Astrophysical Observatory, Victoria, B.C. Vol. 9, No. 13: Spectrographic Orbital Elements for the Binary H.D. 110532. By Andrew McKellar and Hubert Reeves. Pp. 399–406. 25 cents. Vol. 9, No. 14: The Orbits of Two F-Type Spectroscopic Binary Stars. By K. O. Wright and R. E. Pugh. Pp. 407–414. 25 cents. Vol. 10, No. 3: On the Radial-Velocity Variations of κ Draconis. By Anne B. Underhill. Pp. 79–86. 25 cents. (Ottawa: Queen's Printer, 1954 and 1955.) [124

Canada: Department of Mines and Technical Surveys. Publications of the Dominion Observatory, Ottawa. Vol. 14: Bibliography of Seismology. No. 14: Items 8302–8546 (July to December, 1953.) By W. E. T. Smith. Pp. 1+281–308. (Ottawa: Queen's Printer, 1955.) 25 cents. [125

Canada: Department of Mines and Technical Surveys. Geological Survey of Canada. Memoir 275: Geology of Harbour Grace Map-Area, Newfoundland. By R. D. Hutchinson. Pp. v+43 (5 plates). 50 cents. Memoir 277: Southeast Cape Breton Island, Nova Scotia. By L. J. Weeks. Pp. vii+112+1 plate. 75 cents. (Ottawa: Queen's Printer, 1953 and 1954.) [194

Institut pour la Recherche Scientifique en Afrique Centrale. (I.R.S.A.C.) Cinquième Rapport Annuel, 1952. Pp. 377. (Bruxelles: Institut pour la Recherche Scientifique en Afrique Centrale, 1955.) [194

Thirty-fifth Report of the Quebec Society for the Protection of Plants, 1953. Pp. 78. (Quebec: Ministry of Agriculture, 1955.) [194

Canada: Department of Mines and Technical Surveys. Annual Report for the fiscal year 1953–54. Pp. 107. (Ottawa: Queen's Printer, 1954.) [194

Mitteilungen des Deutschen Wetterdienstes. Nr. 11 (Band 2): Zur Bestimmung der Verdinstung auf möglichst einfache Weise. Von Waldemar Haude. Pp. 24. 2.20 D. marks. Nr. 12 (Band 2): Fristschutz mittels Propeller. Von Josef van Eimern. Pp. 30. (Bad Kissingen: Deutschen Wetterdienstes, 1955.) [194

Segundo Symposium sobre Algunos problemas matemáticos que se están estudiando en Latino América, Villavicencio-Mendoza 21–25 Julio, 1954. (Symposium organizado por la Universidad Nacional de Cuyo y el Centro de Cooperacion Cientifica de la Unesco para America Latina.) Pp. 328. (Montevideo: Centro de Cooperacion Cientifica de la Unesco para America Latina, 1954.) [194

Union of South Africa: Department of Commerce and Industries. Division of Fisheries. Investigational Report No. 17: The South African Pilchard (*Sardinops ocellata*). Plankton Studies In and Around St. Helena Bay, 1950–51. By B. v. D. de Jager. Pp. 23. Investigational Report No. 18: The South African Pilchard (*Sardinops ocellata*). Bird Predators, 1953–5. By D. H. Davies. Pp. 32. (Pretoria: Government Printer, 1954 and 1955.) [194

Transactions of the American Philosophical Society. New Series—Vol. 45, Part 1 (1955): Clarence Luther Herrick: Pioneer, Naturalist, Teacher, and Psychobiologist. By Prof. Charles Judson Herrick. Pp. ii+85. (Philadelphia: American Philosophical Society, 1955.) 1.50 dollars. [194

Bernice P. Bishop Museum. Bulletin 214: Archæological Fishbooms Collected by E. W. Gifford in Fiji. By Henry W. Fowler. Pp. 51. (Honolulu: Bernice P. Bishop Museum, 1955.) [194

United States Department of Agriculture. Leaflet 384: Chestnut Weevils: How to Control Them. Pp. 8. (Washington, D.C.: Government Printing Office, 1955.) 5 cents. [194

Informal Report by the U.S. Delegation to the Eighth Session of the General Conference of the United Nations Educational, Scientific and Cultural Organization, November 12–December 10, 1954, Montevideo, Uruguay. (Department of State Publication 5777.) Pp.14. (Washington, D.C.: Department of State, 1955.) [194

Polish Academy of Sciences. Quarterly Review of Publications. Nr. 1. Pp. 36. (Warsaw: Polish Academy of Sciences, 1955.) [194

World Health Organization. Official Records of the World Health Organization No. 59: The Work of WHO, 1954—Annual Report of the Director-General to the World Health Assembly and to the United Nations. Pp. x+210+16 plates. (Geneva: World Health Organization; London: H.M. Stationery Office, 1955.) 10*s*.; 2 dollars; 6 Swiss francs. [194

Science Tools: the LKB Instrument Journal. Vol. 1, No. 1 (April, 1954.) Pp. 8. (Stockholm: LKB-Produkter, 1954.) [194

l'Institut Royal Météorologique de Belgique. Pp. 215. (Ucele, Bruxelles: l'Institut Royal Météorologique de Belgique, 1954.) [194

World University Service. Universities in Africa: Report on a Visit in March–April, 1954. By Douglas J. Aitken. Pp. iv+33. (Geneva and London: World University Service, 1954.) [194

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